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THE ACCOUNTING REVIEW

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A QUARTERLY JOURNAL OF THE
AMERICAN ACCOUNTING ASSOCIATION

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Editor's Note: A "Forum" is a collection of articles around a common theme. Accepted refereed articles are followed by an invited "perspective" authored by experts on that theme. In addition to allowing for synergy and to providing alternative explanations for the results, an objective of the "perspective" is to provide guidance for future research on issues related to that common theme.

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Determinants of Audit Quality in the Public Sector

Donald R. Deis, Jr.
Louisiana State University
Gary A. Giroux
Texas A&M University

SYNOPSIS AND INTRODUCTION: Previous research demonstrates that "brand name" (e.g., Big Eight versus non-Big Eight) is a factor affecting audit prices and auditor selection.[1] As a quality surrogate, brand name reflects differences *between* auditor size categories in concern for reputation (DeAngelo 1981b) and the ability to withstand client pressure (Goldman and Barlev 1974). It has not, however, been demonstrated that these features characterize quality differences *within* an auditor size category. Although tests are difficult without a direct measure of quality, recent announcements by the General Accounting Office on CPA quality in governmental audits indicate a need to determine the factors that affect quality differences within auditor size categories, which is the subject of this study.

Audit quality is defined as the probability that the auditor will both discover and report a breach in the client's accounting system (DeAngelo 1981a). Two explanations for variations in audit quality involve reputation and power conflict. Because an incumbent auditor captures client-specific quasi-rents, there is incentive to lower audit quality to retain the client. However, audit firm size is a moderating effect since a large client base allows a concern for reputation to remain more important than retention of any given client. The expectations are that (1) audit quality decreases as auditor tenure increases and (2) audit quality increases with the number of

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[1] Several studies have addressed this issue, from the perspective of both the private sector (Danos and Eichenseher 1982; Eichenseher and Danos 1981; Francis 1984; Francis and Stokes 1986;Francis and Wilson 1988; Palmrose 1986, 1989; Simon 1985; Simunic 1980) and the public sector (Baber et al. 1987; Copley 1989; O'Keefe et al. 1990; Roberts et al. 1990; Rubin 1988).

We received valuable comments from Earl Wilson, Kris Raman, Linda Ruchala, one anonymous referee, participants in an accounting workshop at Louisiana State University, the *ad hoc* associate editor, and the editor. The first author gratefully acknowledges the Corpus Christi State University Grant Program for funding this research. We are also grateful for the cooperation of Tom Canby and Ed Randall at the Texas Education Agency.

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clients. In power conflicts, the client can exert pressure on the auditor to violate professional standards, and a large, financially healthy client can exert greater pressure with a threat of replacing the auditor. However, the established review of audit results or audit working papers by third parties can increase the auditor's ability to withstand client pressure. The expectations are that (3) audit quality is negatively related to the size and financial health of the firm and (4) audit quality improves when the auditor knows work will be subject to review by third parties and that sanctions for poor quality work will occur.

This article presents the results of an investigation into the determinants of audit quality provided by small, independent CPA firms in Texas on audits of independent school districts. The study analyzes quality control review (QCR) findings to obtain a relatively more direct measure of audit quality. Between 1984 and 1989 the Audit Division of the Texas Education Agency (TEA) conducted 308 QCRs. Numerical scoring of 232 QCR letters of findings represents the measure of minimum audit quality and the dependent variable in the regression analysis. Explanatory variables associated with reputation effects, power conflict effects, report timeliness, audit hours, and reported breaches were obtained from TEA sources. The major finding of the study is that audit quality definitions (DeAngelo 1981b; Goldman and Barlev 1974) considered descriptive *among* audit size categories are sufficiently robust to explain quality variations *within* an audit size group. The results also confirm earlier studies relating audit quality to audit report timeliness (Dwyer and Wilson 1989) and actual audit hours (Palmrose 1986, 1989). We conclude that audit hours is a suitable surrogate for audit quality when direct measures are unavailable.

Key Words: *Audit quality, Reputation, Power conflict, Public sector.*

Data Availability: *The data for this study is available on a 3.5" low density diskette from the first author. To maintain confidentiality, neither the CPA firm nor the school district is identified in the data.*

THE following section describes the theoretical framework for this study and presents hypotheses for testing. The next section describes the empirical method, including the measurement of audit quality by using QCR results. The last two sections cover empirical results and conclusions.

I. Theoretical Framework and Hypotheses

Audit quality is a continuing issue in the profession (AICPA 1987; GAO 1985). A credibility gap in governmental financial reports arose following discovery that poor accounting practices contributed to the fiscal crises of New York and other cities in the 1970s.[2] In response, the federal government issued OMB Circular A-102 in 1979 and

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[2] Besides the absence of an annual audit, Goldin (1985, 270–71) reports that New York City capitalized operating expenses, balanced budgets with uncollectible receivables, consistently overestimated revenues and underestimated expenses, recognized revenues on an accrual basis and expenses on the cash basis, did not

OMB Circular A-128 in 1984, seeking to improve financial reporting practices, increase auditor reporting responsibilities, and establish programs to monitor audit quality.[3] Since then, the financial reporting practices of local governments have improved (Ingram and Robbins 1987). QCRs, however, find audit quality lacking in many CPA-prepared audits (GAO 1985, 1986, 1989; TSBPA 1987), and recent research suggests that audit quality may affect the public sector audit market in unique ways (Copley 1989; Roberts et al. 1990). Like audit failures in the private sector, audit quality deficiencies in the public sector threaten the public's confidence in the profession.

Aside from Dwyer and Wilson (1989), audit quality has not been the explicit focus of public sector audit research. Nonetheless, Rubin (1988) and other recent studies demonstrate that private sector research is generalizable to the public sector. The theoretical framework developed in this study is based primarily on private sector research and will be empirically tested to determine the merits of generalizing various conclusions about private sector audit quality to the public sector.

DeAngelo (1981a) defines audit quality as the probability that an auditor will *both* discover and report a breach in the client's accounting system. The probability of discovering a breach depends on the auditor's technical capabilities and the probability of reporting the error depends on the auditor's independence. Prior studies (DeAngelo 1981a; Goldman and Barlev 1974; Nichols and Price 1976) generally assume that the probability of discovering a breach is positive and fixed (i.e., that all auditors are technically capable) and that auditor independence is the key issue. However, without information about technical capabilities (e.g., auditor experience, education, professionalism, and firm audit structure), capability and independence are difficult to disentangle. Although this study also adopts the independence framework to evaluate the audit quality issue, the importance of technical capabilities is addressed. Two explanations for variations in audit quality vis-à-vis the independence issue are found in the literature. These involve (1) auditor reputation (DeAngelo 1981b) and (2) power conflict (Goldman and Barlev 1974; Nichols and Price 1976). These explanations are adopted as a general theoretical framework for this study.

The Auditor-Reputation Explanation

Incumbent auditors capture client-specific quasi-rents and have incentives to lower quality in future periods to retain the client (DeAngelo 1981b, 189). Audit firm size can militate against such opportunistic behavior because large firms have more audit clients and, therefore, have more to lose from loss of reputation. Also, the threat to their survival from losing a particular client is minimal. Thus, two proxies of audit firm size are thought to affect audit quality: (1) the number of clients and (2) the percentage of audit fees dependent on retaining any one client. Most studies use "brand name" to articulate these definitions. Brand name, however, reflects differences *among* audit firm size groups, but not *within*-group variations. This study sidesteps the brand name

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reconcile bank accounts, did not have a general ledger, and had no control over its cash flow. An analysis of other cities indicated that procedures contrary to generally accepted accounting principles and unaudited financial statements were common practices. In addition, financial difficulties in other cities were possibly exacerbated by poor accounting practices. Cleveland, which defaulted on its long-term debt in 1977, is a well-known example.

[3] OMB Circular A-128 was issued to implement the requirements of the Single Audit Act of 1984.

distinction to test the robustness of existing explanations for variations in audit quality within small (non-Big Eight) CPA firms.[4]

Several recent studies find evidence that auditors discount (i.e., "low ball") the price of initial audit engagements (Baber et al. 1987; Ettredge and Greenberg 1990; Francis and Simon 1987; Roberts et al. 1990; Simon and Francis 1988; Turpen 1990). Low-balling, however, does not imply poor quality on initial audit engagements since auditors are offering initial price discounts to capture future quasi-rents (DeAngelo 1981a, 113). It is the attempt to protect these quasi-rents that threatens auditors' independence. Faced with competitive pricing pressures, an incumbent auditor can choose to lower audit quality and audit price contemporaneously to retain the client and preserve quasi-rents (DeAngelo 1981b, 189). Additionally, over a long association with a client, the auditor may become less challenged and less likely to use innovative audit procedures, or may fail to maintain an attitude of professional skepticism (Mautz and Sharaf 1961; Shockley 1982).[5] The first research hypothesis is based on DeAngelo's explanation of quality deterioration with auditor tenure.

H1: Audit quality decreases as auditor tenure increases.

The consequences of a tarnished reputation contravene opportunistic behavior by an incumbent auditor.[6] An auditor with many clients would be concerned about maintaining reputation and, hence, less likely to lower audit quality (DeAngelo 1981b). Moreover, when the client is an independent school district (ISD), the number of other ISD clients served reflects industry expertise and, therefore, measures variations in technical capabilities. The expectation is that the number of ISD clients would also indicate audit quality, although the interpretation of that effect is confounded between reputational concerns and industry expertise.

H2: Audit quality increases with the number of ISD audit clients.

The Power-Conflict Explanation

This explanation centers on the ability of the auditor to resist pressure from the client to violate professional standards (Goldman and Barlev 1974; Nichols and Price 1976; Shockley 1982). The balance of power tilts toward the audited client whenever the auditor places "greater significance on the rewards mediated by the [client] than the [client] places on the rewards mediated by the auditor" (Nichols and Price 1976, 337).

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[4] Small CPA firms conduct a substantial portion of governmental audits; hence, understanding the factors that contribute to variations in audit quality among these firms is of interest to regulators, professional groups, managers of governmental units, and to CPAs active in the public sector. The ability of existing theories to explain audit quality differences in the small CPA firm category enhances our understanding of audit quality, which is important as the profession continues to face threats of increased regulation and potential loss of its self-regulation status.

[5] Mautz and Sharaf (1961, 208) state that "except in extreme cases, the problem of maintaining independence must rest with the individual practitioner. Occasionally, of course, infringement will be so flagrant that it will come to the attention of those who use the auditor's report or of regulatory agencies or fellow practitioners, and steps will be taken to review the auditor's actions and relationship with the company in question. In a great many more cases, however, the greatest threat to his independence is a *slow, gradual, almost casual erosion of his 'honest disinterestedness'* " (emphasis added).

[6] Several recent studies illustrate the importance of auditor reputation. Wilson and Grimlund (1990) find that auditors experience business loss when low-quality audits are discovered; Palmrose (1988) found lower litigation rates associated with brand name auditors; and changes to a brand name auditor evoke favorable market responses (Eichenseher et al. 1989).

The client desires attested financial statements that will have an expected effect on *particular* third parties,[7] and individual auditor expertise holds little value to the client. Regardless of the nature of the specific audit issues, the client will use pressure to achieve the primary goal of influencing certain third parties. Because the auditor must compete in a competitive market (Rubin 1988; Simon 1985; Simunic 1980) it is easier and less costly for the client to replace the auditor than it is for the auditor to replace lost business.

Knapp (1985) suggests that the size and financial health of an audit client are associated with audit quality. Financially sound audit clients have a low probability of financial failure and so are less likely to expose the auditor to the scrutiny common on such occasions. In such situations, auditors may become complacent and, therefore, less diligent in conducting the audit. Client size and audit price are correlated (Simunic 1980); hence, audits of large clients are enticing to the incumbent auditor's competitors. Large clients, more so than small clients, may be able to use a competitive environment to resolve audit conflicts in their favor. Audit engagements of large, financially sound clients are not necessarily coincident with poor quality audits; rather, the potential for complacency on the part of the auditor and the power exercisable by such clients heighten the *likelihood* of lower audit quality. The power-conflicts explanation leads to the expectation that threats to audit quality increase with the size and financial health of the client.

H3: Audit quality is negatively related to the size and financial health of the client, the ISD.

The power of the auditor increases when there is less room for judgment and interpretation (Magee and Tseng 1990, 332: Nichols and Price 1976, 339–41)[8] and when the profession vigorously enforces professional standards (Goldman and Barlev 1974; Shockley 1982). The Single Audit Act passed by Congress in 1984 led to substantial improvements in accounting and reporting by governmental units. Shortly thereafter, QCR programs commenced and, starting in 1987, the results of those reviews became public.

The auditor's ability to withstand client pressure is dependent on the economics of the contract and certain environmental and behavioral features, including (1) the state of professional ethics, (2) the probability of detection of poor quality, (3) the vigor and visibility of enforcement actions by the profession, (4) the auditor's standing within the professional community, (5) the auditor's level of interaction with professional peer groups, and (6) the auditor's internalization of professional norms.[9] The auditor's ability to withstand pressures from the client to compromise professional standards is enhanced when these features are present. Conversely, as these features are diminished or absent, the auditor is more vulnerable to pressure from the client. Among these features, two are of particular interest because they have been adopted by regulators as techniques to improve audit quality: (1) detection of poor quality by QCRs and (2) enforcement actions by state accountancy boards.

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[7] Possible third parties the client seeks to influence include potential investors, creditors, suppliers, and government oversight agencies. Both private and public sector firms are interested in these third parties.

[8] Nichols and Price (1976, 340) use accounting for R&D expenditures to illustrate how highly structured, routine accounting issues are less likely to be a source of client pressure on the auditor. Auditing for compliance with laws and regulations by governmental agencies, however, is a highly unstructured, nonroutine attestation area—one that might subject the auditor to client pressure.

[9] These features help explain why a brand name effect has been noticed in studies between auditor size groups. Within a homogeneous size group, however, subtle differences in these factors may explain variations in quality. As Goldman and Barlev point out, "One should not conclude that large CPA firms are immune to pressures from their clients. Competition among offices of some large firms for clients may be as great as competition among small, independent CPA firms" (1974, 716). Furthermore, many of these features are interrelated with the technical capabilities of the auditor. For instance, an auditor who internalizes professional norms and is concerned about his or her standing within the professional community is likely to also be devoted to maintaining technical competency.

Increased authoritative guidance and vigorous review programs to monitor CPAs' compliance with professional norms is likely to increase the auditor's power to withstand client pressures. Since initial reports from QCR programs report both substantial problems and sanctions for poor audit quality, auditors were more likely to benefit from increased regulation and monitoring after these reports were issued (i.e., 1987 and thereafter) when the implications of poor work discovered by a QCR became public. The foregoing is stated as the fourth research hypothesis:

H4: Audit quality improves when the auditor knows that his or her work will be subject to review by third parties and that sanctions for poor quality work will be applied.

II. Empirical Method

Audit Quality Model

Audit quality differences within a pooled cross-sectional sample of small, independent auditors is evaluated by using the following model:

$$\begin{aligned} ln(QUALITY) = {} & \alpha_0 + \beta_1 TENURE + \beta_2 CLIENTS + \beta_3 PEER + \beta_4 BOARD \\ & + \beta_5 ln(SIZE) + \beta_6 ln(WEALTH) + \beta_7 YEAR + \beta_8 REPORT \\ & + \beta_9 TIME + \beta_{10} ln(HOURS) + e \end{aligned}$$

where:

$ln(QUALITY)$ = natural log of the weighted quality metric based on the QCR letters of findings.[10]

Reputation effects:

$TENURE$ = number of years the auditor has audited the ISD;
$CLIENTS$ = number of ISD clients audited by the auditor.

Power conflict effects:

$PEER$ = a dummy variable where a 1 indicates that the auditor is a member of the AICPA's Peer Review Section;
$BOARD$ = the percentage of new school board members elected in the last two annual elections in an ISD;
$ln(SIZE)$ = natural log of average daily student attendance for the ISD;

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[10] The natural log of *QUALITY* was used to transform the dependent variable (Gujarati 1978, 210) since the Kolmogorov goodness-of-fit test for normality rejected the assumption of normality at the 0.01 level of significance. Further, OLS regression results exhibit nonrandom patterns in plots of the residual against the predicted value when *QUALITY* (untransformed) is used as the dependent variable. After transformation, the Kolmogorov test fails to reject the normality assumption at the 0.10 level, and residual plots depict a cloudlike pattern.

$\ln(WEALTH)$ = natural log of ISD wealth as measured by assessed property values per student;

$YEAR$ = a dummy variable; a 1 indicates 1987 or 1988 financial statements.

Other variables:

$REPORT$ = a dummy variable; a 1 indicates that the auditor has identified material weaknesses in internal control or material instances of noncompliance with laws and regulations;

$TIME$ = the percentage of the 120 day period in which the audit report must be filed with TEA; calculated as the number of days from fiscal year-end (8/31) to the date of the auditor's report divided by 120 days;

$\ln(HOURS)$ = natural log of the actual audit hours accumulated by the auditor.

QCR Results and Audit Quality Metric

TEA begins with the presumption that the auditor conducts a quality audit in accordance with professional standards. The QCR engagement documents the auditor's breach of those standards. Each QCR engagement culminates in a letter of findings sent to the auditor. There are three possible outcomes: (1) a clean review with no recommendations for improvement,[11] (2) a nonreferred audit listing deficiencies the auditor should correct in future audits, and (3) a referred audit accompanied by a list of deficiencies causing the referral. For clarification, a referred audit is one referred to the Technical Standards Committee of the Texas State Board of Public Accountancy. The committee begins with an informal hearing attended by representatives of TEA and the referred audit firm. A number of sanctions are possible. Some auditors are prohibited from conducting ISD audits until certain continuing professional education (CPE) requirements are met, and others have been instructed to retake parts of the CPA exam; a few licenses have been suspended, and in one case criminal proceedings occurred.[12]

A metric (*QUALITY*) is constructed from the QCR results to serve as the dependent variable in this study. *QUALITY* measures poor quality as defined by the auditor's failure to comply with professional standards; high-quality audits have low *QUALITY* scores. The advantage of this metric is that it reflects the judgment of those at TEA who make the referral decision. Since they have the power to refer auditors for possible sanctions, their assessment of audit quality becomes important for CPA firms. We use this same evidence to arrive at a quality measurement for the sample audits.

A content analysis of the letters of findings identified 19 categories of audit deficiencies. The director of audits ranked the importance of each category, from 1 (most important) to 19 (least important), in making the referral decision. The deficiency categories, their assigned weights, and frequency of occurrence appear in table 1. Each letter was coded for the presence of each category of deficiency; a 1 indicating its

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[11] Clean reviews are rare; only five of the reviews were clean. Two were conducted by large, national auditors and three by small CPA firms.

[12] Attempts by the authors to determine the outcomes of these deliberations were unsuccessful. Recently, the state board changed this policy and, in the future, many of these outcomes will be publicly disclosed in the board's periodic newsletter.

Table 1
QCR Coding and Weights

QCR Findings (Deficiency) Item:	*Assigned Weight**	*Frequency*	
		Count	*Percent*
Internal Control: Major	5	17	7.3
Internal Control: Minor	18	43	18.5
Legal Compliance: Major	3	56	24.1
Legal Compliance: Minor	10	91	39.2
Substantive Tests: Major	7	22	9.5
Substantive Tests: Minor	19	17	7.3
No Engagement Letter	14	36	15.5
No Management Representation Letter	6	33	14.2
Working Papers: Major	2	7	3.0
Working Papers: Minor	17	71	30.6
Audit Program: Major	1	21	9.1
Audit Program: Minor	15	16	6.9
Audit Procedures: Major	4	35	15.1
Audit Procedures: Minor	16	145	62.5
Inadequate Statistical Sampling	13	161	69.4
Inadequate Audit Risk Assessment	12	133	57.3
Errors in Financial Statements	8	80	34.5
Errors in Audit Reports	11	26	11.2
Ethics Violations	9	3	1.3

* SOURCE: Director of Audits, TEA.
1 = most important deficiency area;
19 = least important deficiency area.

presence, 0 otherwise. The metric *QUALITY* was constructed by summing the ratio of each deficiency code (0 or 1) by its assigned weight (1–19). Major audit deficiency areas add more to *QUALITY* than minor deficiencies. For example, major internal control deficiencies add more to *QUALITY* ($1/5 = 0.20$) than minor internal control deficiencies ($1/18 = 0.056$).

QUALITY averages 0.558 and ranges from 0.00 (a clean review) to 3.068 (many deficiencies detected). The construct validity of the metric is verified according to the referral decision; referred audits have significantly higher *QUALITY* scores than nonreferred audits (t-statistic on referred vs. nonreferred means: 12.78, $p = 0.0001$).[13] The range of *QUALITY* for nonreferred audits (from 0.00 to 1.107) overlaps with the range for referred audits (from 0.563 to 3.068) and indicates that additional criteria outside the metric influenced the referral decision (e.g., the cooperative attitude of the auditor during the QCR). Since the goal of this study is to seek explanations for variations in audit quality, as opposed to the prediction of QCR outcomes (i.e., the referral decision), the empirical tests focus on variations in *QUALITY* without attempting further modeling of the regulator's decision-making process.

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[13] Two other quality metrics were evaluated: (1) a simple additive measure summing the number of the 19 audit deficiency areas present and (2) doubling the weights of "major" deficiency areas. Both of these quality measures are correlated with *QUALITY* at 0.90 or better and produced similar results to those reported in this study, which suggests that the results are robust regardless of the manner in which the audit deficiencies are weighed. Since the weighted quality metric reported in this study reflects the thinking of those involved with the QCR engagements and the referral decision, all statistical results in this study are based on this metric.

Auditor-Reputation Effects

As auditor tenure (*TENURE*) increases, audit quality is expected to decrease (higher *QUALITY* score). In contrast, improved audit quality (lower *QUALITY* score) is expected with increases in the number of ISD audits conducted by the audit firm (*CLIENTS*). Banker et al. (1989) indicate that state oversight greatly affects ISD financial reporting practices. Texas ISDs, for example, are subject to extensive reporting and audit requirements, and compliance is monitored by TEA. Poor quality audit work detected by TEA on *any* audit conducted by a CPA firm threatens that firm's ability to retain its other ISD clients. An audit firm specializing in the ISD industry faces concerns about maintaining reputation to protect its investment in specialized resources (e.g., training, standardized audit materials, and decision aids).

Power-Conflict Effects

The importance of the service rendered depends on the nature of the problem and who will benefit from the service (Goldman and Barlev 1974, 711). When audit reports benefit a third party more than management, the auditing profession lacks power and is vulnerable to pressure from the client to resolve conflicts in its favor. Audit firms can decrease the likelihood of succumbing to client pressures by a commitment to professional standards. Membership in the AICPA's Peer Review Section is one way to make such a commitment. Quality review programs tied to sanctions for violating professional standards is an approach the profession and regulators can take to increase an auditor's ability to resist client pressure.

Voluntary membership in the Peer Review Section of the AICPA is evidence of a commitment to maintain professional standards, to interact with peers within the profession, and to internalize professional norms, all of which are likely to help the auditor to resist pressures from the client to deviate from professional standards (Goldman and Barlev 1974; Shockley 1982). Higher audit quality (lower *QUALITY* score) is expected when the firm is a member of the AICPA's Peer Review Section (*PEER*).

Political competition within an ISD can result in changes on the school board and increase administrators' incentives to obtain an acceptable audit report. Parents, teachers, and school board trustees tend to focus more on educational issues than on financial reporting issues (Banker et al. 1989). Nonetheless, the board has the authority to appoint and fire ISD administrators, and political competition may fuel uncertainty. Faced with uncertainty, administrators may try to influence a favorable audit report because the school board's evaluation of their performance will be based, in part, on this report (Goldman and Barlev 1974, 708). Furthermore, the actions of the auditor may be monitored less by an inexperienced board than by an experienced board, thereby allowing the auditor more freedom in the choice of quality. A higher percentage of board turnover (*BOARD*) is expected, as a measure of political competition and board inexperience, to be associated with lower audit quality (higher *QUALITY* score).

Certain client attributes increase the likelihood that client management will both apply pressure and win. Prior studies suggest that as client size (DeAngelo 1981b) and financial health (Knapp 1985) increase, so does the perception that clients can obtain preferred outcomes in an audit conflict. Audit conflict, however, does not always lead to audit failure. Nor should audits of large, financially sound entities be automatically deemed low quality. The power-conflict explanation implies that *if* an audit conflict should occur, a large, financially sound auditee is *more likely* to resolve such conflicts in its favor. Faced with such a prospect, the auditor may seek to avoid conflicts altogether by conducting a lower quality audit. Average student enrollment proxies for client size (*SIZE*) and assessed property values per student proxies for financial health (*WEALTH*).[14] As *SIZE* and *WEALTH* increase, lower audit quality (higher *QUALITY* score) is expected.

Increased enforcement of professional standards helps the auditor maintain independence and resolve audit conflicts according to professional standards (Shockley 1982). Although the QCR program began in 1984 in Texas, the perception that the profession was vigorously enforcing professional standards was not common until 1987 when TEA publicized its results (TSBPA 1987) and an AICPA task force issued a report on the quality of audits of governmental units (AICPA 1987). These reports were indicators for CPAs that a vigorous enforcement program was in place, with sanctions for violations in professional standards. Audits conducted after these announcements are likely to reflect a heightened awareness of business risk associated with governmental audits. If so, audits of financial statements after 1986 (*YEAR*) will have fewer deficiencies (lower *QUALITY* score) than those prior to 1987.

Other Variables

The model includes three additional variables suggested by prior research. A reported breach in the accounting system (*REPORT*) is a de facto component of audit quality in DeAngelo's definition. Auditors will report a breach only if there is sufficient evidence to document the problem conclusively. Whenever the auditor reports material weaknesses in internal control, noncompliance with laws and regulations, or issues a qualified opinion, fewer audit deficiencies (lower *QUALITY* score) are expected. This is measured as a dummy variable, with *REPORT* equal to 1 when at least one breach is reported. This study also considers report timeliness (Dwyer and Wilson 1989) and audit hours (Palmrose 1986, 1989), both found to affect audit quality in prior studies. Texas state law requires the completion of ISD audits before December 31st, within 120 days of fiscal year-end (August 31st). *TIME* is calculated as the number of days from August 31st to the audit report date divided by 120 days. As *TIME* increases, audit quality is expected to decrease (higher *QUALITY* score). *HOURS* is the number of actual audit hours spent on the engagement, and an inverse relationship between actual audit hours and *QUALITY* (score) is expected.

Sample and Data

The audit division of the TEA conducted 308 QCRs over a five-year period (1984–89) on CPA audits of Texas ISDs in six fiscal years (1983–88).[15] Pilot tests, personnel stability, and standardized checklists account for the consistency in the conduct of the QCRs over this time.[16] Nonetheless, 58 QCRs from 1983 and 1984 are omitted because TEA's review questionnaire did not gather audit fee and hour information. Eight repeat QCRs are omitted to prevent those audit firms from being overrepresented in the sample. Ten QCRs of audits by Big Eight and national (second-tier) audit firms, and audits of regional service centers are also eliminated. Audits by large CPA firms were eliminated for a couple of reasons: (1) there were not enough large CPA firm audits to conduct a separate analysis[17] and (2) part of the motivation of this study is to investigate audit quality differences within the small CPA firm category, which is responsible for a large number of public sector audits. The final sample is 232 QCRs conducted by TEA on small CPA firm audits. The sample contains three clean reviews, 197 nonreferred audits, and 32 referred audits. (Subsequent mention of 200 nonreferred audits combines the three clean reviews with the 197 nonreferred audits.)

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[14] On average, more than half of each ISD's revenues is generated from local property taxes. The disparity between ISDs has been a frequent source of conflict between ISD and TEA officals and has been the basis for two lawsuits (one still in progress) by poor ISDs against the state funding system for failing to neutralize local wealth advantages enjoyed by rich ISDs. Both *Rodriquez v. San Antonio Independent School District* (1971) and *Edgewood v. Kirby et al.* (1987) identify individual ISD assessed property values as sources of wealth causing disparities in financial capabilities across districts. ISDs have few sources of revenues, with local property taxes being the main source. Compared to other forms of local government, ISDs are unique in this regard. Further, the percentage of revenues derived from intergovernmental revenues, usually significant in governmental research, is insignificant in ISD financial reporting practices (Banker et al. 1989).

[15] TEA is the noted oversight agency for Texas ISDs. Federal agencies usually review TEA files and do not have a QCR program of their own to review CPA working papers of ISD audits. See Deis et al. (1990) for a description of the TEA's QCR process. Budget curtailments caused TEA to postpone its QCR program in 1990 and 1991.

Data sources for this study come primarily from TEA files. Separate files on each QCR provide audit hours, auditor tenure, AICPA Peer Review Section membership, and QCR result information. TEA electronic database files provide the number of ISD clients for each audit firm, average daily student attendance in the ISDs, and various financial wealth measures. From the annual financial statements we determine whether the auditor reports a breach in the accounting system and the report date. Board turnover is determined by comparing yearly directories of school board officials maintained by TEA. Through special permission from TEA, the authors were given access to all QCR files; all of the other sources are publicly available at TEA.

III. Empirical Results

Descriptive Statistics

Table 2 provides (untransformed) descriptive statistics for the dependent and explanatory variables in the model. The statistics are reported for the total sample (TS), for 32 referred audits (R), and for 200 nonreferred audits (NR). Univariate tests of referred audits, compared with nonreferred audits, indicate lower audit quality ($p=0.0001$), fewer audit hours ($p=0.05$), longer auditor tenure ($p=0.05$), and fewer ISD clients ($p=0.001$). Chi-square tests of association reveal differences in voluntary peer review ($p=0.01$). The two categories of audits were not significantly different in size,

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[16] The stability of the TEA staff during the sample period reduces potential noise from changes in field auditors and decision makers. There were no significant changes in personnel during the sample period, and both the head of the QCR section and the director of audits reviewed the findings of each QCR. Further, the section head appeared at all state board hearings of CPAs referred by the TEA to the Texas State Board of Public Accountancy. The QCR checklist used throughout the sample was developed by the section head and was tested on audits conducted by a national CPA firm. The checklist changed very little over the sample period, with most of the changes related to collecting audit fees and hours after an association between these two factors and quality became apparent. Although there were occasional changes in field auditors (who usually worked in teams of two), an auditor with QCR experience ran every engagement. Further, the authors interviewed all field auditors, the section head, and director and were unable to discern any differences in their perceptions of how the QCR engagements were conducted or of the decision-making process.

[17] QCRs were conducted on audits performed by four large firms: Deloitte Haskins & Sells, Grant Thornton, Peat Marwick & Main, and Coopers & Lybrand. Besides the small frequency of QCRs on large firms, these firms would not be representative of all of the Big Eight and second-tier national firms if retained in the sample. Nonetheless, the results reported throughout this study are similar to those when these large CPA firm audits are included in the analysis.

Table 2
Descriptive Statistics

Variable: (Source)	*Mean Freq: 0/1*	*Range*	*t-statistics & Chi-square*
Quality (QCR Files)	TS: .558	0–3.068	12.78**
	NR: .349	0–1.107	
	R: 1.862	.563–3.068	
Tenure (QCR Files)	TS: 10.09	1–40	1.73*
	NR: 9.60	1–36	
	R: 13.19	1–40	
Clients (ISD) (TEA Records)	TS: 3.29	1–30	−3.72**
	NR: 3.50	1–30	
	R: 2.00	1–7	
Peer Review Member (QCR Files)	TS: 184/48		9.68**
	NR: 152/48		
	R: 32/0		
Board Turnover (%) last 2 years (TEA Records)	TS: 39.0	0–100	−1.08
	NR: 39.7	0–100	
	R: 34.8	0–85.7	
Size (student enrollments) (TEA Records)	TS: 3615	36–44776	1.20
	NR: 3307	36–33966	
	R: 5540	45–44776	
Wealth (assessed property values per student) (TEA Records)	TS: 239134	21979–5404050	1.28
	NR: 209273	21979–1662796	
	R: 425772	44581–5404050	
Year (1987 or later) (QCR Files)	TS: 117/115		2.16
	NR: 97/103		
	R: 20/12		
Report (Breaches reported) (Audit Reports)	TS: 169/63		2.50
	NR: 142/58		
	R: 27/5		
Time (% of 120 day reporting period used) (Audit Reports)	TS: 63.2	15–161	1.06
	NR: 62.6	15–148	
	R: 67.1	27–161	
Audit Hours (QCR Files)	TS: 294	38–1994	−1.73*
	NR: 306	38–1994	
	R: 220	40–1232	

Note: TS: Total Sample (232); NR: Nonreferred Audits (200); R: Referred Audits (32). The *t*-tests and chi-square tests are based on audits classified by referral status (referred: 32 / nonreferred: 200). Chi-square test results are reported for peer review member, year, and reported breaches. All others are *t*-tests.

* Significant at 0.05 (one-tailed *t*-tests).

** Significant at <0.01 (one-tailed *t*-tests).

wealth, board turnover, time period, number of reported breaches, or report timing. There is information loss, however, in reducing audit quality to an ordinal scale based on the referral decision. The multivariate model is used to further explicate variations in audit quality by using *QUALITY* as the dependent variable.

Diagnostic Procedures

Collinearity is loosely considered by analyzing pairwise Spearman rank corrections for all explanatory variables (table 3), variance inflation factors (VIF), condition indexes, and variance-decomposition proportions. No severe problems were noted. Most of the bivariate correlations are low; the highest correlation is between *SIZE* and *HOURS* (0.618), which indicates that larger districts require more audit hours, as expected. None of these correlations appears to produce problems in interpreting the regression results since all the VIF for the explanatory variables are below 2.0, averaging 1.25 and ranging from 1.08 to 1.87. Belsley et al. (1980, 157) suggest a threshold of 15 or 30, below which a condition index can be considered too weak for further consideration. The condition indexes for this model averaged 1.53 and ranged from 1.00 to 2.43. A scatter plot of the residual terms against the predicted value for *QUALITY* from the regression model helped in evaluating heteroscedasticity; the plot depicts a cloudlike pattern centered around a residual value of zero. No obvious outliers appeared in the plot, nor do Cooks-*D*-statistics reveal any.[18] The Goldfeld-Quandt test (Kmenta 1986, 292–93) failed to reject the null hypothesis regarding equality of the variance of the residuals when the sample was ordered according to average daily attendance (*SIZE*) and then split after omitting the middle one-sixth of the observations ($F=1.37$, $p>0.10$). The Glejser test also confirms that heteroscedasticity is not a problem (adjusted $R^2=0.0006$).[19] The Kolmogorov-Smirov goodness-of-fit test for normality of the regression model residuals failed to reject the assumption of normality at the 0.10 level. A *t*-test and signed-rank test indicate a residual mean value of zero ($p=1.0$ and 0.95). Based on these diagnostic procedures, the results of the regression model can be interpreted without concern that they are being influenced by violations in OLS assumptions.

Empirical Model Results

Table 4 presents regression results for the model, with *QUALITY* as the dependent variable. All of the explanatory variables, except *YEAR*, *REPORT*, and *BOARD*, are significant at the 0.10 level or better in the expected relation to audit quality (*QUALITY*). As evidenced by the adjusted R^2 for the model (0.21), a reasonable amount of the variation in *QUALITY* is left unexplained. Other factors that may affect audit quality include education, CPE, previous employment, audit structure, community standing, financial well-being of the audit firm, audit firm resources (e.g., firm library and supervisory capability), professionalism, and work load. Many of these features pertain to the technical capabilities of the audit team and seem appropriate avenues for future research.

The results support the reputation-effects explanation (the first and second research hypotheses). Audit quality declines with the length of auditor tenure

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[18] Three other plots of the residuals—stem and leaf, box, and normal probability plots—confirm that the residuals are normally distributed with a mean near zero.

[19] In the Glejser test (Gujarati 1978, 204-5), the absolute values of the regression model residuals become the dependent variable in a new regression model retaining all of the independent variables used in the original model. Heteroscedasticity is suggested if any of the coefficients are significant in the new regression. *PEER* was significant at 0.05; none of the other coefficients was significant at 0.10 or better in this study. No referred audits were conducted by CPAs who voluntarily participated in the AICPA's peer review program. These audits have the highest values of *QUALITY*; hence, it is not surprising that *PEER* is in some way related to the residuals.

Table 3
Spearman Rank Correlations of Variables

	QUALITY	TENURE	CLIENTS	PEER	BOARD	SIZE	WEALTH	YEAR	REPORT	TIME
TENURE	.066									
CLIENTS	−.168*	.172**								
PEER	−.279**	.073	.086							
BOARD	.009	−.033	.022	.186**						
SIZE	−.168*	.114	.317**	.141*	.037					
WEALTH	.090	.129	−.154*	−.055	−.137*	−.194**				
YEAR	−.061	−.085	−.046	.175**	.206**	−.018	−.049			
REPORT	−.136*	−.081	−.056	.119	.103	.051	.065	.131*		
TIME	.110	−.109	−.200**	.031	−.010	−.042	−.056	.019	.126	
HOURS	−.341**	−.011	.102	.159*	.028	.618**	−.147*	−.007	.127	.056

* Correlations significant at 0.05.
** Correlations significant at <0.01.

Table 4
Regression Results for Audit Quality

Description	*Predicted Sign*	*Coefficient*	*t-statistic*
Intercept		−1.140	−1.014
Auditor Tenure (*TENURE*)	+	0.016	2.612***
Number of ISD Audit Clients (*CLIENTS*)	−	−0.028	−2.017**
Member AICPA Peer Review Section (*PEER*)	−	−0.532	−3.986***
% of Board Elected in Last 2 Years (*BOARD*)	+	0.261	1.151
Number of Students (*SIZE*)	+	0.113	2.248**
Assessed Property Value Per Student (*WEALTH*)	+	0.113	1.484*
0/1=Report Year 1987 or Later (*YEAR*)	−	−0.024	−0.226
0/1=Auditor Reports Breach (*REPORT*)	−	−0.102	−0.851
% of 120 Day Audit Period Used (*TIME*)	+	0.645	2.689***
Actual Audit Hours (*HOURS*)	−	−0.453	−4.767***

Note: The model is expressed as:

$$\ln(QUALITY)=\alpha_0+\beta_1 TENURE+\beta_2 CLIENTS+\beta_3 PEER+\beta_4 BOARD+\beta_5 \ln(SIZE)$$
$$+\beta_6 \ln(WEALTH)+\beta_7 YEAR+\beta_8 REPORT+\beta_9 TIME+\beta_{10} \ln(HOURS).$$

The dependent variable is the natural log of weighted quality score. (High values of *QUALITY* indicate low quality audit work.) The F-statistic for model: 7.116 ($p=0.0001$); R^2: 0.24, adjusted R^2: 0.21.

* Significant at 0.10 (one-tailed *t*-tests).
** Significant at 0.05 (one-tailed *t*-tests).
*** Significant at <0.01 (one-tailed *t*-tests).

(*TENURE*: $p=0.01$). This decline can be attributed to either opportunistic behavior (DeAngelo 1981b) or complacency (Shockley 1982). Audit quality improves as the firm's number of ISD clients increases (*CLIENTS*: $p=0.05$). The interpretation of this result, however, is confounded between the auditor's concern for reputation and improved technical capabilities as a result of industry expertise.

The results also support research hypotheses H3 and H4 based on the power conflict explanation of audit quality. Larger (*SIZE*: $p=0.05$), financially healthy (*WEALTH*: $p=0.10$) clients receive lower quality audits, in agreement with previous studies showing that financial statement users *perceive* auditors of large, healthy clients as less independent (Knapp 1985; Pany and Reckers 1980). Board turnover (*BOARD*) also relates to lower quality audits as expected, although it is not statistically significant. Audit firms that are members of the AICPA's Peer Review Section (*PEER*) conduct higher quality audits (p=0.0001). During the period under study, this membership was voluntary and so was likely to represent an internalization of professional standards at the audit firm.[20] It is unclear whether mandated peer review requirements will have the same effect. As in the univariate tests, *YEAR* is not significant in the model.[21] If QCR programs affect audit quality, it may be more by eliminating incompetence than by encouraging improved audit approaches. Therefore it may take time for improvements in audit quality to occur as a result of QCR programs.

Three other variables suggested by prior research are associated in the expected relation with audit quality. *REPORT* is negative in the regression model but not significant. More timely reports (*TIME*) are of higher audit quality (p=0.01), and audit quality improves with increased audit hours (*HOURS*: p=0.0001).

IV. Conclusions

A QCR program is one approach regulators have chosen to improve audit quality. The early results of these programs indicated that audit quality was lacking for a large percentage of governmental audits. This study tests some factors that have been suggested in the literature as influencing audit quality. Factors related to both reputation and power conflicts are significant determinants of audit quality. Client-specific quasi-rents relate to lower audit quality, but the number of audit clients can militate against these quasi-rents (DeAngelo 1981b). Certain characteristics increase the client's ability to obtain favorable results, but the audit firm's commitment to professional standards helps to constrain client power (Goldman and Barlev 1974). That is, the results support *both* explanations of audit quality found in the literature, which suggests that audit quality is a complex issue. Although past studies demonstrate that brand name is a useful surrogate for quality differences *among* auditor size groups, this study reveals that quality differences *within* an auditor size group are more complex. On the basis of the strong relationship between audit hours and audit quality (the −0.341 bivariate correlation coefficient between *QUALITY* and *HOURS* was significant at the 0.0001 level), the number of audit hours seems to be an acceptable surrogate for audit quality differences among audit firms of similar size when a direct measure of audit quality is unavailable.

Interpretation of the results of this study needs to be tempered by the recognition that the evidence pertains to one type of governmental unit (ISDs) in a single state (Texas). Hence, the generalizability of the results may be limited. Future research could study audit quality differences in markets comprised of larger CPA firms, or audits of private sector entities. Variations in audit procurement procedures affect audit fees (Rubin 1988), but do they also affect audit quality? If so, a study relating various audit procurement practices to audit quality would be of interest.

Given the importance placed on education in governmental auditing (AICPA 1987), it might be useful for future research to investigate the effects of variations in technical capabilities on audit quality. Moreover, the interpretation of some variables, such as the number of ISD clients (*CLIENTS*) in this study, confounds explanations based on technical capabilities and auditor independence. Is an audit not conducted according to professional guidelines because of a willful decision or because of lack of knowledge? In either case, the result is the same—a professional standard is violated. Future research may attempt to isolate attributes of technical capabilities (e.g., educational background, professional development, employment history, work load, community standing, supervision, audit structure, and characteristics of the audit team) from those of independence (e.g., willingness to report a breach, resolution of audit conflicts with the client according to professional standards, and the ability to maintain professional standards when faced with competitive pressures).

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[20] GAO established mandatory peer review requirements after the time period of this study.

[21] A better test of this relationship requires information on audit quality before the QCR program began, which is unfortunately unavailable.

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Market Segmentation and the Association between Municipal Financial Disclosure and Net Interest Costs

Ehsan H. Feroz
University of Minnesota–Duluth
Earl R. Wilson
University of Missouri–Columbia

SYNOPSIS AND INTRODUCTION: This study provides evidence that market segmentation affects the strength of the association between financial disclosure and net interest cost for new issues of municipal bonds. Previous studies (see, e.g., Amershi and Ramamurtie 1990; Cook 1982; Hendershott and Kidwell 1978; Kidwell et al. 1983) show that the geographic segmentation of primary markets for municipal bonds along regional and national lines is characterized by different sources and costs of information. Because little information is available from alternative sources for the less marketable bonds of smaller issuers which use regional markets, financial reporting variables are hypothesized to be associated more strongly with interest costs for these issues than for those of larger municipalities, whose bonds are typically issued in the national bond market.

Cook (1982) argues that the costs of obtaining information about small issuers from alternative sources are relatively high. For these issuers, who also do not issue bonds frequently, regional underwriters may be the only informational intermediaries (other than rating agencies if the bonds are rated) between the issuers and investors (Kidwell et al. 1983). Thus, financial and other entity-specific information contained in the offering statement are expected to be weighted more heavily in pricing these bonds than for bonds of larger issuers. Although this differential-information

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hypothesis is analogous to Atiase's (1985) argument regarding differential predisclosure of information, our study assumes differential availability of information across market segments, and size alone is not likely to be an adequate proxy for segmentation. Our main analysis uses the nature of the underwriting syndicate, whether it is managed by a national or regional underwriter, to proxy for the relevant market segment.

Previous studies of municipal accounting (see, e.g., Ingram and Copeland 1982; Wallace 1981; Wilson and Howard 1984) have provided evidence of an association between bond measures and accounting and auditing variables. However, the results were mixed and inconsistent, which may be attributable to differences in the entities examined (cities, counties, and school districts), the time periods examined, or definitions of variables. Also, differences in the mix of bonds issued in each segment may have contributed to the inconsistent results. By examining the relationship between accounting and auditing variables and bond interest costs separately for each segment of the primary bond market, our study provides useful evidence on the potential effect of different information environments on this relationship.

Regression results based on a sample of 119 new municipal bond issues, partitioned on a measure of segmentation (regional vs. national underwriter), are consistent with the hypothesis that the association between the quality and quantity of financial disclosure and interest costs is stronger for municipalities that issue bonds in local or regional markets than for those that issue bonds in the national market. Our results suggest that future research in this area should consider the potential effects of market segmentation when testing the association between accounting or auditing variables and bond interest costs.

Key Words: *Market segmentation, Marketability, Financial disclosure, Municipal bonds.*

Data Availability: *The data used in this study will be made available from the authors upon request.*

THE remainder of this article is organized as follows. Section I develops the theory and the differential-information hypothesis investigated in this study. Section II examines the empirical and theoretical support for segmentation of the municipal bond market and evaluates relevant institutional factors. Section III explains the research method (model, data, and sample selection). Section IV presents and discusses the empirical findings. Finally, section V provides the conclusions of the study.

I. Theory and the Differential-Information Hypothesis

This study assumes geographic segmentation of the primary market for new issues into regional or national sectors to examine the effects of informational differences on the association between municipal financial disclosure and interest costs.[1] This

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[1] The distinction between national and regional underwriters is explained by Lamb and Rappaport (1987, 35) as follows:

> Municipal bond selling (unlike the selling or underwriting of corporate securities) tends to require so much more on-the-spot local knowledge of a particular town, school system, public

geographic segmentation is a result, in part, of high search costs for reliable information about the bonds of smaller issuers.[2] Regional underwriters are thus able to gain a comparative bidding advantage by developing specialized information on these less marketable bonds of smaller issuers in their region.[3] Institutional bidding rules ensure that a majority of the less marketable bond issues of smaller issuers will self-select into a geographically segmented (regional) market.[4]

Informational differences in the national and regional markets suggest that the usefulness of accounting and auditing information in pricing bonds may differ between market segments. Specifically, we hypothesize that the dearth of alternative sources of pricing information for the bonds of smaller, less frequent issuers causes accounting and auditing information in the official (offering) statements to be more important than comparable information associated with new issues in the national market. In particular, the prices (interest costs) of bonds issued in the regional markets will be more sensitive to financial indicators of management quality (e.g., quality and quantity of disclosure, use of a high-quality audit firm, and professional recognition for quality financial reporting) since direct observation of management performance is not

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> facility, or public authority that the *regional firm* has an advantage over the *New York investment firms* in knowing a specific municipality, its economic and debt trends, its financial position, the caliber of its management, and the market for the bonds (emphases added).

Although Lamb and Rappaport note that many "New York firms" increased their network of branch offices during the 1970s to better compete with regional firms for smaller issuers, the regional firms "in some regions still dominate the municipal market" (1987, 35). The fact that many national underwriters maintain local branch offices does not preclude regional segmentation. As Moak (1982, 269) notes:

> national firms must operate through local offices and these offices sometimes have priorities that supersede the sale of the bonds of a particular issuer. At the same time, many regional firms have easier access to important local investors than do local offices of national firms.

Thus, the potential for market segmentation based on the informational advantage of regional underwriters still exists.

[2] Cook (1982, 31) notes:

> The first and most widely cited reason why regional market conditions may affect tax-exempt bond yields is information costs... many municipal bond issues are relatively small and are handled by local or regional underwriters that sell primarily in local or regional markets... the cost to an underwriter (and hence to an issuer) of searching for and identifying distant buyers for the bond might be considerable. If these costs are significant, then the yields on bonds in a region could deviate from the "going" yields on similar bonds outside the region.

[3] "Less marketable" means that underwriters will have more difficulty in selling the bonds of these issuers at a normal profit spread. Lamb and Rappaport (1987) refer to marketability primarily in terms of the availability of willing buyers, which will depend on general credit market conditions and such characteristics of the bonds as maturity structure, call status, whether or not insured, and assigned rating. They also note (p. 25) the importance of the "credit name" or familiarity of the buyers with the issuer. Marketability is closely related to segmentation since, in general, bonds with low marketability are more likely to be purchased by an underwriting syndicate headed by a regional underwriter.

[4] Most municipal general obligation bond issues of more then $1 million, the size examined in this study, are issued in serial maturities and sold via competitive bid to the underwriting syndicate submitting the lowest net interest cost, as defined in table 1. Thus, if regional underwriters possess an informational advantage in bidding for bond issues of smaller issuers in their region, they will be more likely than national underwriters to tender the winning bid. This institutional restriction tends to self-select smaller issuers into a regional market with fewer potential buyers since regional underwriters mainly sell to investors in their region. Even though syndicates headed by a regional underwriter often include one or more national underwriters to improve access to investors, there is no available information on how much of each issue is typically allocated to the national underwriters or whether these underwriters assume a substantial risk for bonds of low marketability.

feasible and few alternative sources of information about performance are available.[5]

In contrast, information about larger cities is readily available from secondary sources such as the news media, credit reports from the major rating services, credit analyses in *Moody's Municipal and Government Manual*, publications of the U.S. Bureau of Census, and specialized reports and analyses by researchers. This feature renders the bonds of large issuers relatively more marketable to a larger pool of investors in the national market. Further, Moak (1982, 47) notes that some information is nonperishable in the short run because of "traditional accounts," or reformation of the same syndicate that handled a previous issue to bid on a new issue. Given the relatively stable nature of many economic factors (e.g., population, employment base, retail sales, and property values), a frequent issuer's credit risk is likely to change only slightly between successive issues. It follows that underwriters and investors will be more familiar with the bonds of larger cities as a result of their more frequent issues, and search costs for information about the issuer will be lower.

In summary, our differential-information hypothesis is then stated in alternative form as:

> Ha1: The strength of association between accounting and auditing variables and net interest costs for new issues of municipal general obligation bonds will be greater for those issued in regional markets than for those issued in the national market.

II. Market Segmentation and Institutional Factors

Previous finance studies (e.g., Forbes and Leonard 1984; Hendershott and Kidwell 1978; Kessel 1971; Kidwell and Koch 1983; Kidwell et al. 1983; Leonard 1983) have demonstrated empirically that the municipal bond market is not homogeneous; rather, it is segmented "into distinct groups according to their preferences for particular types of securities and that a lack of substitution between groups implies that yield spreads are explained by the relative demands of the groups" (Campbell 1980, 71). Kidwell et al. (1983, 2) state that "the primary causes of geographic segmentation are changes in relative security supplies in a state, regional and state government pledging requirements, and differences in state laws regarding the taxation of municipal bonds issued within and outside the state." Cook (1982) and Lamb and Rappaport (1987) argue that high search costs for information about the bonds of smaller issuers permit regional underwriters to benefit from specialized information about these issuers. Differences in information costs plus differences in state pledging and taxing structures preclude arbitraging on regional yield differences and permit regional markets to persist.

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[5] Our segmentation arguments do not depend on signalling incentives for management of smaller, less marketable issuers to improve their disclosure. Although such arguments have been made in the literature (see, e.g., Evans and Patton 1983, 1987; Wilson and Stewart 1990), testing that differences in marketability provide signalling incentives to improve disclosure is problematic. As one reviewer pointed out, superior management, rather than superior disclosure, may be the cause of greater marketability. Indeed, the studies cited above suggest that the quality of financial reporting will be used by investors as a proxy for quality of financial management. Our rationale relies mainly on differences in the amount of relevant pricing information from alternative sources in the markets for the bonds of smaller issuers and that for the bonds of larger issuers. This rationale is therefore closer to the differential-predisclosure argument of Atiase (1985) than to the signalling argument.

Amershi and Ramamurtie (1990) provide a theoretical rationale for market segmentation within the framework of a noisy rational-expectations equilibrium. Their model starts with an economy segmented into different asset markets with traders active in two regional markets and one central market.[6] Although the traders in one market may be aware of the assets in other markets, they might not have sufficient "common knowlege" about the precise payoff characteristics of the assets to sustain a fully revealing (as opposed to a partially revealing or noisy) rational-expectations equilibrium. Amershi and Ramamurtie's (1990) main result shows that, in an economy with segmentation, there exists a noisy rational-expectations equilibrium (with purely intermarket or endogenous trading noise as opposed to exogenous, random supply noise) that permits traders with private asset information to derive rents.

Amershi and Ramamurtie's (1990) second major result demonstrates that a noisy rational-expectations equilibrium allows segmentation to persist. This means that market segmentation will persist in equilibrium which is contrary to the traditional capital asset pricing model and non-segmented rational-expectation equilibrium models. "In particular, the result implies that without the help of 'intermediaries' who specialize in searching out asset values in different markets, there is no scope for investors to hold fully diversified portfolios spanning all assets in the economy" (1990, 8). They provide examples of segmented markets, including the municipal bond market.

Thus, the extant literature provides both theoretical and empirical support for our hypothesis of market segmentation in terms of regional versus national markets. These studies suggest that access to the national bond market is difficult for many smaller municipalities because the low frequency of issues and institutional restrictions (e.g., taxes or pledging requirements) make information too costly for national underwriters to compete with the specialized knowledge of local or regional underwriters.[7] Thus, the bonds of these cities are more likely to be marketed to regional underwriters, commercial banks, or institutional investors who are familiar with the local issuers (Van Horne 1984).

III. Model, Data, and Sample Selection

To test the hypothesis that accounting and auditing variables are more strongly associated with net interest cost for bonds issued in regional markets, we utilize a multiple regression model. This model contains control variables that have been used in prior studies to explain variations in net interest costs (*NIC*) as well as several test

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[6] Segmentation in their model refers to a lack of common knowledge among the traders in different markets. "Common knowledge" refers to the information that is known to every trader publicly as opposed to privately (Aumann 1976).

[7] In terms of marketing strategy, the bond issues of smaller issuers are often purchased by local or regional underwriters and reoffered regionally because marginal search costs associated with the regional underwriters locating the investors outside the issuer's locality may exceed the marginal benefits from reduced interest expense. "Thus high information costs may effectively restrict the market for many issues to local investors which allow interest rate differentials to exist between similar bonds in different geographic markets" (Kidwell et al. 1983, 4).

Table 1
Description of Variables

Variable	*Description*
Dependent Variable:	
NIC	Net interest cost (%) of winning bid. *NIC* is defined as the total interest to be paid over the life of the bonds, adjusted for any issue discount or premium, divided by the bond years. Bond years $= \Sigma$ (face amount $\times t$), where the face amount is the amount of bonds maturing during year *t*.
Independent Variables:	
BBIND	Bond Buyer 20-bond index for week of issue (%).
AVMAT	Average maturity of the bond series issued, in years.
Aa, A1, A, Baa1, Baa	Indicator variables for Moody's bond ratings (Aaa is the excluded class).
INDEX	Disclosure index of "important" and "vitally important" disclosures, as reported by Rees (1982). (See the appendix and text for description.)
COFCONF	Holder of GFOA Certificate of Conformance, 1 = yes, 0 = no (currently called the certificate of achievement for excellence in financial reporting).
BIG8AUD	Big Eight Auditor (1 = yes; 0 = no) (now referred to as Big Six).
UWIND	Interaction variable having value of 0 if syndicate is headed by a national underwriter and value of INDEX if headed by a regional underwriter; a national underwriter is a firm headquartered in New York City (see fns. 4 and 11).
UWCERT	Interaction variable having value of 0 if syndicate is headed by a national underwriter and value of COFCONF if headed by a regional underwriter.
UWBIG8	Interaction variable having value of 0 if syndicate is headed by a national underwriter and value of BIG8AUD if headed by a regional underwriter.
POPIND	Interaction variable having value of 0 if the city population is above the 1980 median and value of INDEX if below median.
POPCERT	Interaction variable having value of 0 if city population is above the 1980 median and value of COFCONF if below median.
POPBIG8	Interaction variable having value of 0 if city population is above the 1980 median and value of BIG8AUD if below median.
SIZEIND	Interaction variable having value of 0 if size of issue is above median and value of INDEX if below median.
SIZECERT	Interaction variable having value of 0 if size of issue is above median and value of COFCONF if below median.
SIZEBIG8	Interaction variable having value of 0 if size of issue is above median and value of BIG8AUD if below median.

variables that indicate the quantity and quality of financial disclosures[8] (see table 1) and is stated as:

$$NIC = f(\text{market interest rate, average maturity, bond ratings, and financial disclosure ``test'' variables}). \quad (1)$$

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[8] This model is similar to the typical model used in previous segmentation studies and in 25 municipal bond studies summarized by Cook (1982).

The major determinant of *NIC* is the market rate of interest at the time of the new issue. To control for market, we included the Bond Buyer 20-bond Index for the week of the new issue.[9] This index is widely used as a benchmark for primary market yields and has been used as a proxy for the market interest rate of municipal bonds (Cook 1982). *NIC* should vary directly with the market rate of interest. The index was obtained from post-sale data sheets published by the Bond Buyer.

Lamb and Rappaport (1987, 17–21) note that bonds with longer maturities tend to be more difficult to market than those with shorter maturities. Moreover, the term structure of municipal yields is typically upward sloping (Kidwell and Koch 1983). To capture this effect, the average maturity (in years) of the bond issue was used, and this information was also obtained from the post-sale data sheets.

Marketability of a bond issue is also affected by its default risk, for which we used several dummy control variables representing Moody's rating categories. The higher the bond rating, the lower the borrowing cost. Again, the data were obtained from the post-sale sheets.

Finally, three financial reporting measures were included to provide alternative tests of the association between financial reporting practices and interest costs. The first variable is an indicator for whether the municipality had received a certificate of conformance (COFCONF) (now called the certificate of achievement) from the Government Finance Officers' Association (GFOA) for quality financial reporting. The second variable is a measure of the extent (quantity) of financial disclosure in the official statement (i.e., bond prospectus). This measure (INDEX) represents the percentage of 57 "important" and "vitally important" items in the official statement, as identified by Rees (1982) from a survey of 192 municipal bond underwriters. The final variable was a dummy variable indicating whether the city utilized a Big Eight (now Big Six) audit firm. Herhold (1986) provides evidence that municipal bond analysts consider use of a Big Eight audit firm to be a positive factor in evaluating general obligation credit risk. COFCONF and auditor type were also test variables in Wallace (1981) and Wilson and Howard (1984), and both studies also used a crude GAAP compliance index. Thus, the present study includes three of the test variables used previously in two similar studies.

To examine whether informational differences between market segments affect the association between *NIC* and the financial reporting variables, interaction variables were developed between each financial reporting variable and the type of underwriter, national versus regional.[10] To evaluate the sensitivity of the results to the type of underwriter proxy, separate analyses were conducted with two additional segmentation proxies, size of issue (above or below median) and size of issuer (above or below median population).[11] Issuer size (i.e., population) should be correlated with other factors such as the availability of alternative information sources that reflect information search costs and marketability. Hendershott and Kidwell (1978) state that issues below $10 million are usually handled by regional underwriters; otherwise, issues are handled by national underwriters. To make the issue size measure consistent with that for size of issuer, our results are based on partitioning above and below the median of our sample ($7.5 million); however, we also used a $10 million cutoff with similar results.

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[9] This index is based on market yields for 20 actively traded bonds with an average 20-year maturity. The Public Securities Association (1990) notes that virtually all publicly sold municipal bonds are reported immediately by the Bond Buyer (a proprietary market information source) over its *Munifacts* wire service and the *Daily Bond Buyer*, a daily market news service. Among the standard disclosures in these news releases is the 20-bond Index for the most recent week, which serves as the primary market benchmark for gauging the relative cost of the bonds being purchased by the underwriter.

[10] We are indebted to a referee for suggesting this testing approach, which permits a direct test of the effects of segmentation.

[11] As reported in footnote 1, the professional literature (see, e.g., Lamb and Rappaport 1987) views large underwriters in financial centers such as Chicago, San Francisco, Atlanta, Dallas, Minneapolis, etc., as *regional*. The larger investment firms and banks headquartered in New York City are considered *national*

The disclosure index was constructed by using weights obtained from the importance ratings reported by Rees (1982). The items included descriptions of property tax procedures, debt structure, revenue sources, budgeting procedures, significant accounting policies, carrying value of assets, pension disclosures, and other disclosures, such as the nature and amounts of fund balance reserves, deficits and restrictions on assets. Only applicable items were included in the index, which is simply the weighted sum of disclosed items divided by the weighted sum of all applicable items and multiplied by 100. Thus, the metric could range from zero for no disclosure of these items to 100 percent for full disclosure. The appendix provides a description of all information items in the disclosure index, including the underwriter weights assigned to each item. Data for these information items were obtained mainly from official offering statements, which typically contain at least the audited general purpose financial statements (GPFS), including notes. However, some data needed to construct the disclosure index were obtained from the annual financial reports of cities that did not include GPFS with their offering statements. This is not construed as problematic since, at the time of a new issue, at least bond rating agencies would have access to the annual financial reports as well as the offering statements.

The financial disclosure variables are considered alternative proxies that capture to some extent both the quality and quantity of financial disclosure, although certain complementary relations exist. For example, cities applying for a certificate of conformance must meet disclosure standards well in excess of minimum GAAP requirements. Thus, these cities are more likely to have high disclosure index measures. We expect an inverse relationship between the level (quantity and quality) of disclosure and borrowing costs; however, as hypothesized, we expect the association to be stronger for cities that issue bonds in a local or regional market than for those in the national market.

Table 1 describes the variables used in the NIC model. The predicted signs for each variable are provided in table 4, which shows the regression results.

Sample Selection and Data Sources

The sample consists of 119 new general obligation (GO) bond issues made by 100 cities between 1978 and 1983.[12] These issues were selected from a larger data base

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underwriters. Even though many of these firms have established regional offices, Moak (1982) notes that the regional underwriters continue to maintain a specialized informational advantage for issuers in their region. Thus, we believe the designation of New York City underwriters as "national" and all others as "regional" is reasonably descriptive of current institutional arrangements in the municipal bond market. Nevertheless, we also conducted all tests with the two alternative segmentation measures suggested in the literature: size of city and size of issue.

[12] No city had more than two bond issues in the sample, and most of the double issues were two or more years apart. Nevertheless, we conducted all tests using only one issue per city ($n = 100$); and the results were similar to those reported. The *t*-ratios for some test variables were somewhat smaller, though still significant; those for other test variables were somewhat stronger. The slight differences observed are likely due to differences in sample size and do not indicate any bias from inclusion of more than one issue for some cities.

Table 2
Descriptive Statistics and Univariate Tests for Regional vs. National Underwriter

	Total Sample (N=119)		*Regional*[a] *Underwriter* (N=57)		*National*[b] *Underwriter* (N=62)	
Variable	*Mean*	*S.D.*	*Mean*	*S.D.*	*Mean*	*S.D.*
NIC	9.228	2.039	8.885	1.994	9.544	2.044
POP[c] (000's)***	194.875	303.969	106.330	113.960	276.279	390.835
AVMAT (in years)	10.298	3.129	10.365	2.932	10.237	3.323
RATING[d] (Moody's)	4.151	1.239	4.018	1.126	4.274	1.333
BONDAMT[c]***($Million)	12.671	13.713	8.772	9.415	16.255	15.973
INDEX*	43.240	21.160	40.489	22.084	45.769	20.120
COFCONF (0–1)	0.185	0.390	0.193	0.398	0.177	0.385
BIG8AUD**	0.513	0.502	0.404	0.495	0.613	0.491

Note: The levels of significance are based on a one-tailed test of difference between groups with Mann-Whitney *U*-test for continuous variables and two-tailed chi-square test for dummy variables.

* $p<0.10$,
** $p<0.05$,
*** $p<0.01$.

[a] If the winning underwriting syndicate was headed by a regional (or local) underwriter, it was placed in the regional underwriter subsample.

[b] If the winning underwriting syndicate was headed by a national underwriter (defined as one headquartered in New York City), it was placed in the national underwriter subsample. (See fns. 1 and 11 for the rationale for this classification.)

[c] The population (POP) and the amount of the bond issue (BONDAMT) are shown here for descriptive purposes only. In the alternative test regressions, dummy variables indicating above- or below-median population and above- and below-median issue size are used to form interaction variables with the three accounting test variables (see table 1 for explanations).

[d] Moody's bond rating is shown here as an ordinal variable for descriptive purposes only (1=Ba, 2=Baa, 3=A, 4=A1, 5=Aa, 6=Aaa).

maintained by one of the authors, and represent all of the municipal issues for which the required data were available. Although the sample was not randomly selected, it is broadly distributed across all geographic regions and population strata, and appears to be reasonably representative of all cities issuing bonds via competitive bidding. Only cities with a population of more than 25,000 were included since financial data for smaller cities are difficult to obtain.

IV. Results and Discussion

The descriptive statistics and univariate tests are shown in table 2. The strongest differences between markets (segments) involve issuer size (POP) and bond amount (BONDAMT), as expected; both are significantly different at the 0.01 level with a Mann-Whitney *U*-test. Cities attracting a national underwriter are more than twice as large, on average, as those using a regional underwriter, and the average bond issue of

Table 3
Spearman Rank Correlations for Independent Variables

		X1	X2	X3	X4	X5	X6	X7
POP	(X1)	1.00						
AVMAT	(X2)	0.01	1.00					
RATING	(X3)	0.24	−0.10	1.00				
BONDAMT	(X4)	0.71	0.12	0.08	1.00			
INDEX	(X5)	0.35	−0.19	0.29	0.22	1.00		
COFCONF	(X6)	0.22	0.01	0.03	0.05	0.09	1.00	
BIG8AUD	(X7)	0.40	−0.13	0.07	0.38	0.20	−0.06	1.00

Note: Correlations of approximately 0.18 are significant at the 0.05 level.

cities using a national underwriter is nearly double that of cities using a regional underwriter.

Two of the financial disclosure variables, INDEX and BIG8AUD, are significantly higher for the national underwriter group, at the 0.10 level for INDEX and 0.05 level for BIG8AUD.[13] Of the cities with a national underwriter, 61.3 percent used a Big Eight auditor, compared to only 40.4 percent of cities with a regional underwriter. The percentage of cities in the national market holding a certificate of conformance (COFCONF) is 17.7 percent, slightly lower than the percentage for cities in a regional market, 19.3 percent.

Table 3 displays pairwise Spearman rank correlations for all explanatory and partitioning (POP and BONDAMT) variables. These correlations do not suggest serious collinearity problems, given that the highly collinear variables (POP and BONDAMT) shown in table 3 are not used together in the same regression model. We also examined a more reliable indicator of collinearity, the variance inflation factor (VIF) for each explanatory variable,[14] and none exceeded 4.00 in magnitude (a level of 10 is generally regarded as indicating a significant problem; Marquardt 1970).

OLS Regression Results

The OLS regressions reported in table 4 examine whether, as hypothesized, the type of underwriter (market segment) affects the strength of association between the quantity and quality of financial disclosure and borrowing costs. All of the significant control variables are associated with borrowing cost (*NIC*) in the expected direction. Overall, the models explain from 95.5 to 95.8 percent of the variation in *NIC*. Of major

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[13] Our hypothesis is that the *strength* of association between the disclosure variables and *NIC* will be greater, on average, for cities in the regional bond market. However, we expected larger cities (i.e., those more likely to issue bonds in the national market) to have better disclosure on *average* than smaller cities. This expectation is based on the probability that the accounting and finance staffs of larger cities will have greater technical ability and better training. Also, the sheer size and scope of accounting functions of larger cities make it more likely they will engage larger audit firms with the necessary technical resources to accomplish their audits.

[14] The variance inflation factor is the reciprocal of 1 minus the R-square when a particular independent variable is regressed on all other independent variables.

Table 4
OLS Regression Models with *NIC* as Dependent Variable and Interaction of Type of Underwriter with Accounting Variables as Test Variables
(n=119)

Pred.		*Model 1* *Disclosure Index*				*Model 2* *Certificate of Conformance*				*Model 3* *Big Eight Auditor*			
		Model 1A		*Model 1B*		*Model 2A*		*Model 2B*		*Model 3A*		*Model 3B*	
Var.	*Sign*	*Coef.*	*t-stat.*	*Coef.*	*t-stat.*	*Coef.*	*t-stat.*	*Coef.*	*t-stat.*	*Coef.*	*t-stat.*	*Coef.*	*t-stat.*
Constant	?	−1.487	−4.88	−1.455	−4.93	−1.610	−5.60	−1.528	−5.30	−1.611	−5.37	−1.584	−5.35
BBIND	(+)	0.920	45.82#	0.919	47.04#	0.915	46.22#	0.912	46.32#	0.913	46.63#	0.910	46.98#
AVMAT	(+)	0.122	9.20#	0.120	9.24#	0.125	9.46#	0.122	9.25#	0.125	9.30#	0.125	9.44#
AA	(+)	−0.008	−0.05	−0.059	−0.41	0.009	0.06	−0.018	−0.13	0.018	0.12	0.011	0.07
A1	(+)	0.164	0.99	0.191	1.18	0.238	1.55*	0.221	1.45*	0.246	1.55*	0.239	1.53*
A	(+)	0.306	1.89**	0.338	2.14**	0.346	2.18**	0.343	2.18**	0.349	2.16**	0.379	2.37***
BAA1	(+)	1.028	2.96***	1.074	3.17#	1.108	3.25#	1.106	3.28#	1.129	3.32#	1.165	3.47#
BAA	(+)	1.705	8.04#	1.646	7.93#	1.705	7.95#	1.696	7.99#	1.721	8.00#	1.697	7.99#
INDEX	(−)	−0.003	−1.22	−0.000	−0.13								
UWIND	(−)			−0.005	−2.66***								
COFCONF	(−)					−0.067	−0.63	0.105	0.75				
UWCERT	(−)							−0.342	−1.83**				
BIG8AUD	(−)									0.010	0.11	0.102	1.03
UWBIG8	(−)											−0.233	−2.01**
Model F-value		315.38#		296.62#		312.20#		283.77#		311.05#		284.57#	
Adj. R-square		0.955		0.958		0.955		0.956		0.955		0.956	
Partial F-test[a]				7.08**				3.33*				4.04**	

Note: Levels of significance: one-tailed except for F-tests which are two-tailed.

* $p<0.10$,
** $p<0.05$,
*** $p<0.01$,
# $p<0.001$.

[a] The partial F-test determines whether the adjusted R-square for model B is significantly greater than for model A.

explanatory value are the control variables, market interest rate (BBIND), average maturity (AVMAT), and default risk (rating dummies BAA and BAA1). These results are consistent with those of most other studies (see, e.g., Cook 1982).[15]

Our main interest is whether the financial disclosure variables are associated with borrowing costs and whether that association is affected by the type of underwriter used. The results in table 4 are consistent with this hypothesis. As the results for models 1B, 2B, and 3B show, *NIC* is significantly associated with all three interaction variables, at the 0.01 level for the disclosure index interaction with underwriter type (UWIND) and at the 0.05 level for the Certificate of Conformance (UWCERT) and type of auditor (UWBIG8) interactions, but *NIC* is not significantly associated with the main effect of any test variable.[16] These results indicate that the association between disclosure variables and interest costs is significantly different for the subsample of 57 cities issuing bonds in regional markets and the 62 cities issuing bonds in the national market. As shown for models 1A, 2A, and 3A, we also ran full-sample regressions excluding the interaction variables (i.e., using only the main effect variables INDEX, COFCONF, and BIG8AUD). None of the three main effect variables was significant at conventional levels.

To further evaluate the sensitivity of the results, we conducted a more conservative test, with "regional" defined as the 54 issues in which the syndicate was headed by a regional underwriter but included one or more national underwriters as members, and "national" defined as the 40 issues in which the syndicate was headed by a national firm but included one or more regional firms as members. All results with this 94-issue subsample are similar to those reported in table 4, and all test variables have the same level of significance.

Despite the significant coefficients for the interaction test variables, adjusted *R*-square values are only slightly increased, which questions the economic (rather than statistical) significance of our findings. Overall, the accounting and auditing variables seem to affect *NIC* to a lesser extent than do the control variables.

Alternative Segmentation Proxies

Results from the analysis of the alternative segmentation proxies based on size of issuer and size of issue are generally consistent with, though somewhat weaker than, the main results shown in table 4.[17] Our results for city size show that the interaction of population with the disclosure index and with the type of auditor are both significant at the 0.05 level, whereas the interaction of population with certificate of conformance is not significant. This suggests that the decision to seek a certificate is unrelated to the size of the city, in conformance with the descriptive statistics shown in table 2. Results for the alternative test based on interactions with size of issue show significance at the 0.10 level for certificate of conformance but insignificant associations with the disclosure index and auditor type. However, the latter variables are at about the 0.10 level of significance.

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[15] We tested for violation of all regression assumptions. Inspections of residuals revealed no problems with heteroscedasticity or nonnormality. A Kolmogorov-Smirnov test accepted the null hypothesis that the residuals were normally distributed at $p > 0.15$. Cook's *D*- and studentized-range-statistics were examined for the presence of influential observations, and none were observed.

[16] Robbins and Austin (1986) report robust results using subsets of their disclosure index, which was similar to the Rees (1982) index. To test the sensitivity of our results to the specific index used, we also ran model 1 in table 4 using an index composed of a subset of 40 GAAP-required items and an index using 14 items designated by underwriters in the Rees study as "vitally important." The results (available from the authors) were very similar to those reported, indicating that the results are not sensitive to the specific index used. Additional regressions using the Rees disclosure index without underwriter weights produced results that were virtually identical to those reported in table 4 with underwriter weights.

[17] For the sake of brevity, the results of these alternative tests are not reported but are available from the authors upon request.

The results suggest that these alternative proxies for segmentation may be inferior to the regional versus national partitioning used in our main tests. Overall, however, the regression results with the three segmentation measures provide evidence consistent with the differential information hypothesis that the association between financial reporting measures and *NIC* is stronger for the generally less marketable bonds of smaller cities in regional markets than for the bonds of larger cities in the national market.

Comparison with Prior Studies

How do our findings compare with the two prior studies (Wallace 1981; Wilson and Howard 1984) that used similar models and tested the same or similar variables?[18] Wallace (1981) in her interest cost models for 106 new issues by Florida cities, counties, and school districts, found a GAAP conformance measure to be significant; however, this variable was insignificant for a reduced sample of 73 issues by cities only. She found no significant results for our other two test variables, type of auditor and the GFOA certificate of conformance. Wilson and Howard (1984), in a national sample of 230 new issues by cities and counties, found no significant associations for a GAAP conformance index, type of auditor, and GFOA certificate of conformance. However, for a subsample of 168 cities only, the type of auditor was weakly significant ($p<0.10$) and the certificate of conformance was significant at the 0.05 level. Thus, the results of prior studies appear to be sample-specific and indicate a generally stronger relationship between accounting/auditing variables and interest costs when the sample is restricted only to cities. In contrast, our results are consistent for the three financial reporting variables: none of the main effect ("A") models are significant; all of the interaction ("B") models are significant. Thus, controlling for market segment appears to improve the consistency of results.

The different findings of the prior studies may be attributable to sampling differences (entities in Florida for Wallace 1981; national sample for Wilson and Howard 1984), different time periods (1974–76 for Wallace; 1978–81 for Wilson and Howard), and different GAAP conformance measures. However, if our hypothesis holds and the samples used in these prior studies differed in the mix of national versus regional underwritings, then market segmentation could have contributed to the inconsistent results of the two prior studies. This is an empirical issue that we are unable to address.

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[18] Although there have been many accounting studies involving municipal bonds, Wallace (1981) and Wilson and Howard (1984) appear to be the only two that specifically examine the *NIC* of new issues and use variables similar to those in our study. See Ingram et al. (1987) for a review of accounting studies involving municipal bonds.

V. Summary and Conclusions

In this study, we examined the association between municipal financial disclosure and NIC in terms of finance studies that have suggested that the municipal bond market is segmented. Our results indicate that financial reporting measures are more strongly associated with NIC in the regional primary markets (defined by composition of the underwriting syndicate) than in the national market. Slightly weaker but generally consistent results were obtained with alternative segmentation proxies—size of the city and size of the issue. One limitation of this study was the necessity to include in our sample hybrid syndicates consisting of both national and regional underwriters because of the small number of underwritings that occur in practice by syndicates comprised solely of national or regional firms. Nevertheless, our results suggest that syndicate leadership (whether managed by a national or regional underwriter) provides an adequate (and perhaps conservative) proxy for market segmentation.

The results suggest that reporting quality is higher overall for municipalities operating in the national market but, since there are fewer alternative sources of relevant pricing information for bonds issued by smaller issuers, underwriters and investors in regional markets seem to react more strongly to variations in the quantity and quality of financial disclosure in pricing bonds. One implication is that smaller cities might improve the marketability of their bonds by improving their financial reporting practices.

Finally, our findings suggest that researchers need to be sensitive to the institutional structures characterizing the municipal bond market. A logical extension of this study would be to identify other potentially segmented markets, such as the market for initial public offerings of corporate equity securities, which may also be characterized by informational differences. If other segmented markets exist, the usefulness of accounting information may also differ across market segments, as appears to be the case for municipal bonds.

Appendix

Information Items Included in Disclosure Index

Description of property taxes:

- Assessed valuation (2.31)

Valuation basis for proprietary fund

- Frequency of reassessment (2.72)
- Actual tax rate (2.78)
- Portion of tax levy applicable to debt services (2.67)
- Maximum statutory tax rate (2.76)
- Accounting treatment for delinquent taxes (2.51)
- Description of principal taxpayers (2.70)

Description of debt structure:

- Legal limitation on incurrence of debt (2.91)
- Description of debt margin (2.67)
- Overlapping debt (2.76)
- Debt service requirements (2.87)
- Compliance with debt service requirements (2.80)
- Amount of authorized but unissued debt (2.76)

Description of other revenue sources and interfund transactions:

- Identification of all major revenue sources (2.83)
- Existence of any interfund receivables and payables (2.48)
- Amounts of interfund transfers (2.55)
- Use of federal grant proceeds (2.40)

Disclosure of budgetary procedures:

- Basis on which budget is prepared (2.57)
- Identification of funds for which an annual budget is prepared (2.56)
- Treatment of encumbrances outstanding at year-end (2.50)
- Treatment of unencumbered appropriations at year-end (2.53)

Appendix—*Continued*
Information Items Included in Disclosure Index

Summary of significant accounting policies:

- Description of funds used (2.68)
- Identification of revenues subject to accrual (2.54)
- Identification of measurement focus (2.18)
- Description of the reporting entity (2.31)

Carrying value of assets:

- Valuation basis for investment (2.32)
- Assessment ratio (2.77)
- Fixed assets (2.14)
- Depreciation policy on proprietary fund fixed assets (2.17)
- Policy for capitalization of interest during construction (2.34)

Pension disclosure:

- Number of plans maintained (2.48)
- Identification of which plans are locally or state administered (2.40)
- Identification of which employees are covered by each plan (2.14)
- Actuarially determined amount of city's required contributions (2.54)
- Annual amount actually contributed by city (2.63)
- Annual amount contributed by employees (2.35)
- Amount recognized as an expense or expenditure during the year (2.41)
- Statement of expense/expenditure (2.32)
- Amount of unfunded prior service costs (2.70)
- Amortization period for unfunded obligations (2.55)
- Disclosure of funding policy (2.57)
- Market value of pension assets (2.48)
- Amount of vested benefits (2.49)
- Difference between the actuarially computed value of vested benefits and the pension fund assets (2.56)
- Date of latest actuarial valuation (2.60)
- Statement of significant actuarial assumptions (2.28)
- Any changes in actuarial assumptions during current year (2.41)
- Net change in market value of pension fund assets (2.26)
- Investment earnings on pension fund assets (2.24)
- Benefit paid to retirees during the year (2.23)

Other disclosures:

- Nature and amount of fund balance or retained earnings reserves (2.74)
- Identification of any deficit fund balance (2.72)
- Nature and amount of any fund balance designations by management (2.61)
- Amount of restricted assets in enterprise funds (2.61)
- Segment information for enterprise funds (2.46)
- Excess of expenditures over budgeted expenditures (2.57)
- Changes in general long-term debt (2.55)

Note: The underwriters' relative weights are in parentheses, shown as the average for all underwriters on a scale ranging from 0 (no importance) to 3 (vital importance).

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A Perspective on Research in Governmental Accounting

Rajiv D. Banker
University of Minnesota–Minneapolis
William W. Cooper
University of Texas–Austin
Gordon Potter
University of Minnesota–Minneapolis

SYNOPSIS AND INTRODUCTION: According to the December 1991 issue of the *Survey of Current Business,* expenditures of state and local governments account for more than 11 percent of the U.S. gross domestic product. Moody's 1991 Municipal Manual indicates that these governmental entities have an outstanding debt now approaching $800 billion, and a report by the Public Securities Association (1987) indicates that this debt grew at a compound annual rate of 12 percent from 1966 to 1986. State and local governmental activities continue to increase in magnitude, and evidently form an important part of the political and economic environment in which accounting operates. Important accountability issues distinctive to these organizations need accounting research attention.

The articles by Feroz and Wilson and Deis and Giroux in this issue, which we have been invited to review, address some of these topics. The study by Feroz and Wilson can be regarded as an extension to the public sector of capital-market-based research that examines the effects of financial-accounting disclosures on security prices and returns. They hypothesize segmentation of the market for municipal obligations along national and regional lines and study the effects of differential information disclosure on borrowing costs. In the other study, Deis and Giroux utilize quality reviews that were conducted by the Texas Education Agency to evaluate and rate the audits (by public accountants) of public schools' financial reports. They test hypotheses about audit quality that were originally developed in the context of commercial firms. Both studies thus represent extensions of theories and methods used in research of private-sector accounting and auditing issues. The contributions of the two articles are discussed, and modifications that consider the unique aspects of governmental accounting are presented in sections I and II. Other possible avenues for research are discussed in section III.

Invited by the Editor.

I. Feroz and Wilson's Paper

NUMEROUS studies in governmental accounting have investigated the role of financial reporting by local and state governments in credit evaluation. This research has consistently documented that accounting variables are useful in explaining bond rating classifications, as well as net interest costs (Ingram et al. 1987). In addition, studies by Wallace (1981) and Wilson and Howard (1984) suggest that substandard reporting practices result in lower bond ratings or higher borrowing costs. A closely related body of research has addressed other aspects of the disclosure policies of governmental units. For instance, Ingram and Dejong (1987) document that cities in states whose regulations do not conform with generally accepted accounting principles (GAAP) have less disclosure than those in unregulated or GAAP-regulated states. Giroux (1989) examines the influence of political factors on disclosure and Evans and Patton (1983) investigate links between disclosure and government form and size.

Feroz and Wilson's study represents a further step in the assessment of the effect of the quality of financial disclosure on the determination of the financing costs of municipalities. Closely related to the work of Wallace (1981) and Wilson and Howard (1984), its primary innovation is an explicit recognition of market segmentation in the municipal debt market. Feroz and Wilson hypothesize that the usefulness of financial disclosure depends on the market the instrument trades in. In the national market, investors are easily able to obtain alternative information to determine credit worthiness, and therefore the quality of the financial disclosure is not priced. Because there is little alternative information on the quality of management in the regional markets, the cost of a debt issue decreases with disclosure quality in that market.

Three measures of disclosure quality are identified and tested by Feroz and Wilson, who examine 119 bond issues marketed by 100 cities from 1978 to 1983. These measures are (1) a disclosure index developed by Rees (1982), (2) auditor type, and (3) professional certificate of conformance. They find that disclosure quality is not related to financing costs in the national underwriting market, but a significant negative association between disclosure quality and net interest cost (*NIC*) exists in the regional underwriting market. The authors then replicate their findings using city and bond issue size as alternative proxies for market segmentation.

Feroz and Wilson's explicit consideration of segmented markets is an interesting extension of the financing cost literature. Their arguments regarding the availability of alternative information parallel those used in capital-markets research. Specifically, they state that their argument is analogous to that of Atiase (1985) in that accounting information at the time of the bond offering is expected to have a greater effect on prices when there is a lack of alternative information, as is usual for municipalities whose bonds trade in the regional market. Their approach, however, does not examine the effect of the reported information on the calibration of prices, which might be investigated by examining the association between the magnitude of price changes and disclosure quality at the report's release date. Rather, they investigate the degree to which disclosure quality is valuable in reducing interest costs. This requires a link between the information conveyed in the signal and the prices of municipal bonds.

Feroz and Wilson assert that disclosure, type of audit firm, and professional certification are indicators of management competency. Evans and Patton (1987) used a similar signalling argument to explain city managers' incentives for obtaining a certificate of conformance. Presumably then, all three variables—the disclosure index, auditor type, and certification of conformance—proxy for the same variable, management quality. If management quality reduces the likelihood of default risk, then the higher the signal, the lower the bond interest costs. Because there is sufficient alternative information in the national market to assess management competency, investors' priors on management quality are precise. However, because there is little information in the regional market, traders have diffuse priors on management quality and therefore weight the disclosure index heavily in determining high-quality management.

If management competency is the underlying construct then this *latent variable* should be estimated initially by combining each of its three proxies. To clarify what is involved consider the following system of equations:

$$NIC = \alpha_0 + \alpha_1 MGTQLT + \alpha_2 BONDRAT + \alpha_3 AVMAT + \alpha_4 BBIND + \sum_{k=1}^{K} \alpha_{4+k} FINVAR_k, \quad (1)$$

$$BONDRAT = \beta_0 + \sum_{k=1}^{K} \beta_k FINVAR_k + \beta_{K+1} MGTQLT, \quad (2)$$

$$MGTQLT = \gamma_0 + \gamma_1 INDEX + \gamma_2 COFCONF + \gamma_3 BIG8AUD, \quad (3)$$

where the symbols are defined as in Feroz and Wilson with the following two exceptions. *BONDRAT* is a discrete variable reflecting bond rating, $FINVAR_k$, $k = 1, \ldots, K$, which are financial variables used to explain bond rating as in Wallace (1981). *MGTQLT* is the latent variable representing management quality. This recursive system of equations suggests that *MGTQLT* could affect *NIC* in different ways, for instance, through β_{K+1} in the bond-rating equation (2) or via α_1 in equation (1), the *NIC* equation. These possible differences in the causal paths suggest alternative testing strategies with latent-variable analysis. Unfortunately, we cannot estimate these equations because information on financial variables is not available to us.

The reason bond costs fluctuate with the quality of accounting and auditing requires a more thorough discussion than that supplied in Feroz and Wilson. For instance, in footnote 5, they seem to reject the notion that these disclosure variables signal management quality. Moreover, many of their citations seem to imply that regional underwriters are closer to the issuers (fn. 1). If regional investors are closer to the issuer, why is the disclosure index more useful in the regional market than in the national market? Although we believe the authors have made a convincing argument that the municipal bond market may be segmented, they have not been entirely successful in explaining how this segmentation affects investors and the value of information.

There are reasons to question whether the data really support the argument of disclosure quality. Given that Standard and Poor's credit rating agency explicitly considers disclosure quality in the rating process,[1] why does the bond rating not fully capture the effect of the disclosure policy? That disclosure quality would drive bond ratings appears to be consistent with the work of Wallace (1981) who finds a statistically significant association between bond ratings and measures of audit quality.

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[1] In 1980, Standard and Poor's announced that it would accord a negative factor in its ratings of reports not prepared according to GAAP or some modification. (See Standard and Poor's Corp. 1983.)

If bond ratings fully capture the quality of disclosure, why should a significant relationship exist between *NIC* and disclosure quality in the segmented market? One potential reason is that the interaction variable *UWIND* is correlated with some missing factor.

The number of bidders in the underwriting market for the bonds and the effect of state laws may be related both to underwriter type and *NIC*. Research has consistently shown a significant negative relation between number of bidders and interest costs (Cook 1982). Hence, disclosure could be spuriously correlated with number of bidders; conversely, high-quality disclosure could attract more bidders. Evidence of the latter would be of special interest. Prior research has also documented that disclosure is in part driven by state laws (Banker et al. 1989a; Ingram and Dejong 1987). Moreover, many states require GAAP. Thus, disclosure quality may be driven by state-specific factors as well as by signals from management. We know that net interest costs are driven in part by state pledging requirements. State taxes may also have differential effects on yields although such a relationship has not yet been documented empirically. In Feroz and Wilson's examination, we know nothing of the state representation or number of bidders in the sample. Although they define two distinct markets for municipal bonds for which yields may vary due to the supply and demand characteristics, no acknowledgment of this fact is embedded in the estimation of *NIC*.

Feroz and Wilson's table 1 reveals that the *NIC* in the regional market is *lower* than that in the national market over their sample period, a finding that is interesting in its own right. This yield differential is the essence of segmented markets, that is, different yields result from varying supply and demand characteristics. A regression with a dummy variable indicating type of market (1 = regional, 0 = national) may control for these potential shifts in interest costs across markets, as shown in our table 1. The regression reported by Feroz and Wilson in their table 4 as model 1B is shown in the left column of our table 1. Note that their model allows for only a slope difference across market types. The regression reported in the middle column of our table 1 (including *UW*) allows for both a slope and an intercept difference. The table reveals that it is virtually impossible to distinguish the effect of disclosure type (*UWIND*) from the overall regional effect (*UW*). That is, the slope change on the disclosure index for the regional issues noted in the regression on the left may be proxying for the difference in mean *NIC* across markets, rather than for disclosure differentials. Left unanswered is what drives this yield differential. It may be that disclosure quality does drive these differences; it is important, however, that theories of disclosure developed in for-profit environments be modified in the governmental market. Other drivers of disclosure unique to the state and local environment need to be incorporated in the research design.

A primary distinction between the financial reporting of governmental units and that of commercial businesses concerns the end users of the financial statements. Although many parties may be interested in the reports of commercial enterprises, the information needs of investors and creditors have been emphasized (SFAC No. 1). Governmental accounting reports are also used by creditors,[2] but governmental agen-

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[2] In 1985, new issues of municipal bonds totaled $222 billion and exceeded total private-sector capital issues by $30 billion (Public Securities Association 1987).

Table 1

Extension of Feroz and Wilson's Regression Model 1B, Table 4

(Absolute *t*-statistics in parentheses)

$$NIC=\alpha+\beta_1 BBIND+\beta_2 AVMAT+\beta_4 A1+\beta_5 A+\beta_6 BAA1+\beta_7 BAA+\beta_8 INDEX+\beta_9 UWIND+\beta_{10} UW$$

	Feroz and Wilson	*Including* UW	*Excluding* UWIND
INTERCEPT	−1.455	−1.425	−1.355
	(4.93)	(4.59)	(4.52)
BBIND	0.919	0.917	0.915
	(47.04)	(46.29)	(46.60)
AVMAT	0.120	0.120	0.122
	(9.24)	(9.13)	(9.43)
AA	−0.059	−0.054	−0.035
	(0.41)	(0.37)	(0.24)
A1	0.191	0.197	0.208
	(1.18)	(1.21)	(1.28)
A	0.338	0.339	0.339
	(2.14)	(2.14)	(2.14)
BAA1	1.074	1.069	1.051
	(3.17)	(3.14)	(3.09)
BAA	1.646	1.649	1.668
	(7.93)	(7.90)	(8.04)
INDEX	−0.000	−0.001	−0.003
	(0.13)	(0.29)	(1.19)
UWIND	−0.005	−0.003	—
	(2.66)	(0.88)	—
UW	—	−0.058	−0.206
	—	(0.31)	(2.52)
p (model)	0.0001	0.0001	0.0001
Adjusted R^2	0.9575	0.9572	0.9573

Note: *UW*=1 for a regional market, 0 otherwise. The definitions of other variables are as in Feroz and Wilson.

cies do not have a unique group of investors or equity holders. Rather, these entities provide information to diverse but important constituencies such as grantors, taxpayers, voters, legislators, and oversight boards. Therefore, measures of performance cannot be reduced to a simple "bottom line" notion such as earnings or return on investment. Governmental reporting to various constituencies requires information on whether the unit is operating efficiently, effectively, and according to the specific guidelines of these interested parties.

Examination of how governmental accounting information is processed by decision makers other than creditors is an important area for future research on governmental financial-reporting issues. We know little about whether and how taxpayers incorporate accounting information, such as fund deficits or debt levels, in their voting decisions. Governmental units, such as legislative bodies, delegate tasks to managers, appropriations are made, and resources are then consumed. Because many of the outcomes are not financial, it is not clear how voters, managers, taxpayers, legislative committees, and oversight boards utilize accounting information.

An example of research that links accounting information and governmental constituencies is the Giroux and Wiggins (1987) analysis of accounting numbers and levels of government grants. Giroux and Wiggins find that intergovernmental grant levels increase with the fiscal surplus of the grantee rather than with fiscal deficit. Another example is Epple and Schipper's (1981) analysis of the underfunding of pension obligations by municipalities. Their evidence suggests that pension underfunding is capitalized into lower housing prices. Issues regarding "interperiod equity" are considered important elements of accountability by the Government Accounting Standards Board (GASB 1990). Further research on the link between the accrual accounting system, management decisions, and economic outcomes (Goldin 1985) will help delineate the effects of governmental financial reports. More generally, a promising avenue for research in this area involves investigation of how the array of constituencies use accounting information to allocate resources and make other decisions.

II. Deis and Giroux's Paper

Recent auditing research concerning governmental units has included audit pricing (Beck and Barefield 1986), school board auditor changes (Roberts et al. 1990), audit fees (Baber et al. 1987; Rubin 1988), and the relation of audit budgets to credit costs (Marks and Raman 1986). Much of this research has used concepts that were initially developed for explaining auditing phenomena in the commercial sector. Hence, the results have tended to confirm many of the findings from the private sector. Although testing theories in different markets is useful in that it helps determine a theory's generalizability, there may be unique variables within markets. One such unique explanatory variable in many governmental studies is political competition. Baber et al. (1987) find that political competition is positively related to audit fees. As they point out, however, they have no theory to explain their finding. Introducing the preferences of other interested parties into the governmental auditing environment would be fruitful for future research.

Deis and Giroux's study examines factors determining quality of governmental audits. Their hypotheses are based on theories that were originally developed in the context of the private sector. Their principal hypotheses are that audit quality increases with reputation effects and decreases with the power of the client. The reputation-effect argument rests on the assumption that auditors will cut quality to retain clients without substantially increasing audit fees. The extent of the quality reduction, however, will be traded off against the potential loss in future audit engagements and fees in the event that an audit firm's reputation is damaged. The power-conflict argument states that wealthy clients hire auditors principally to satisfy the requirements of third parties. Such clients are not interested in the auditor's findings *per se* and will exert pressure on the auditor to perform a low-quality audit.

Deis and Giroux test their hypotheses using 232 observations of audit quality obtained from quality reviews by the Audit Division of the Texas Education Agency

Table 2
Factor Analysis of Deficiency Items for the Deis-Giroux Study

		Factor Analytic Weights	
Deficiency Item	*Deis and Giroux: Perceived Rank by Director of Audits*	*Factor 1: Major Audit Deficiencies*	*Factor 2: Minor Audit Deficiencies*
Internal Control: Major	5	0.308	−0.182
Internal Control: Minor	18	0.065	0.474
Legal Compliance: Major	3	0.325	−0.038
Legal Compliance: Minor	10	−0.170	0.188
Substantive Tests: Major	7	0.402	−0.055
Substantive Tests: Minor	19	0.033	0.260
No Engagement Letter	14	0.331	0.016
No Management Representation Letter	6	0.301	0.057
Working Papers: Major	2	0.238	−0.041
Working Papers: Minor	17	0.070	0.184
Audit Program: Major	1	0.394	−0.035
Audit Program: Minor	15	−0.016	0.227
Audit Procedures: Major	4	0.306	0.223
Audit Procedures: Minor	16	−0.179	−0.039
Inadequate Statistical Sampling	13	0.036	0.439
Inadequate Audit Risk Assessment	12	−0.006	0.500
Errors in Financial Statements	8	0.060	0.103
Errors in Audit Reports	11	0.123	0.106
Ethics Violations	9	0.194	−0.164

(TEA), which reviewed public accountants' audits of school districts.[3] The regression results show that auditor quality increases with number of auditor clients, and decreases with school district wealth, and audit tenure. They conclude that their results support both the reputation and power conflict arguments.

Deis and Giroux develop a continuous metric of audit quality to relate to predictor variables. Their measure of audit quality is constructed by weighting the responses to 19 deficiency areas examined by the TEA audit teams. Because prior studies essentially infer audit quality from auditor type (e.g., Big Eight vs. non-Big Eight), Deis and Giroux state that their metric is a more refined measure of quality. We agree with their assertion. A primary contribution of the study is the development of a quality metric that allows for a more complete test of established theories of audit quality.

A problem, however, arises in deciding how the 19 variables from the compliance reports should be weighted in order to construct a proxy of auditor quality. Deis and Giroux chose to weight the 19 variables in inverse relation to their perceived importance as determined by the director of audits of the TEA (see the second column of our table 2). An alternative approach would estimate a logistic response function model to predict the referral decision and have the weights inputed by means of maximum likelihood estimates. This would help reduce the subjectivity that is implicit in the approach of Deis and Giroux. From table 2 of their study, an overlap is evident between the range that incorporates all of the non-referrals (0 – 1.107) and the quality for the referrals (0.563 – 3.086). It is an empirical issue whether the ranges from a logit model overlap less than those from the subjective weightings. We examined the association between the 19 deficiency variables and the referral decision using a logit model. The results revealed that the referral decision was predictable. Each referral decision could be explained as a combination of the 19 deficiency variables. In fact, the referral decision could be explained with a 97 percent accuracy by using a subset of only five of the 19 variables. Because of high collinearity among many of the deficiency variables, we chose not to interpret the individual coefficients. The results from logit estimation are reassuring in that they suggest that the referral decision is predicated on concepts used by Deis and Giroux as measures of audit quality.

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[3] Such quality reviews, originally mandated by the U.S. Office of Management and Budget, have been enacted into law by Congress in the Single Audit Act of 1984, so this practice has spread to many states as well as to the federal government. See Deis et al. (1990) and Berry and Harwood (1987).

The high collinearity of the individual deficiency items in Deis and Giroux suggests that audit quality may be measured by just a few main attributes. Therefore, we also conducted a principal-components analysis using the 19 deficiency items to identify common dimensions. The two most important factors are described in our table 2. The first factor explains approximately 25 percent of the variation in markings and the second explains 10 percent. These two factors have a natural interpretation. The loadings on the first factor suggest that this component represents major audit deficiencies in internal control, legal compliance, substantive testing, and audit programs and procedures. A review of the loadings for the second factor suggest that it represents minor deficiencies. The high correlation (0.86) between the first factor and the referral decision of the TEA indicates that referral decisions are based on major audit deficiencies, as opposed to (1) the overall quality metric designed by Deis and Giroux, which has a correlation of 0.63 with the referral decision, or (2) our minor audit deficiencies factor, which has a correlation of –0.02 with the referral decision.

In table 3, we report estimates from regressions with the same predictors as in Deis and Giroux. The three alternative quality metrics used as dependent variables are the referral decision and the two principal factors, as discussed above.[4] It is reassuring to note that the general results reported by the authors are also present in the logit and primary-factor models. In fact, the results from our model of the major audit deficiencies are very similar to those reported by the authors. This triangulation helps to delineate precisely what their quality metric represents.

A review of the regression results in table 4 of Deis and Giroux are generally supportive of their primary hypotheses. One variable they include as a control variable is audit hours,[5] which they document is positively related to quality. We agree that hours and quality are related, but surmise that both are jointly determined by the auditor. Therefore, OLS estimates lead to simultaneous equations bias. In a manner similar to O'Brien and Bhushan (1990) we estimate the following system of simultaneous equations:

$$\begin{aligned}QUALITY = {} & \beta_0 + \beta_1 TENURE + \beta_2 CLIENTS + \beta_3 PEER + \beta_4 BOARD \\ & + \beta_5 WEALTH + \beta_6 YEAR + \beta_7 REPORT + \beta_8 TIME + \beta_9 HOURS;\end{aligned}$$

$$\begin{aligned}HOURS = {} & \phi_0 + \phi_1 TENURE + \phi_2 CLIENTS + \phi_3 SIZE + \phi_4 WEALTH \\ & + \phi_5 TIME + \phi_6 QUALITY.\end{aligned}$$

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[4] Seemingly unrelated regression procedure is not required because the independent variables are identical. Since referral decision is a dummy variable, parameters and standard errors are estimated by using a logit model.

[5] The high correlation between *HOURS* and *SIZE* in Deis and Giroux's model results in a Belsley-Kuh-Welsch condition index of 32.54, with variance proportions of 0.556 and 0.938 for the two variables.

Table 3

Alternative Measures of Audit Quality for the Deis-Giroux Study

(Absolute z- or t-statistics in parentheses)

$$Q=\beta_0+\beta_1 TENURE_i+\beta_2 CLIENT_i+\beta_3 PEER_i+\beta_4 BOARD_i+\beta_5 SIZE +\beta_6 WEALTH+\beta_7 YEAR+\beta_8 REPORT+\beta_9 TIME+\beta_{10} HOURS$$

Variable	*Referral (0, 1) (Logit Estimation)*	*Factor 1: Major Audit Deficiencies*	*Factor 2: Minor Audit Deficiencies*
INTERCEPT	NA	NA	NA
TENURE	0.035	0.050	−0.011
	(1.45)	(3.33)	(1.00)
CLIENTS	−0.185	−0.074	−0.005
	(1.77)	(2.14)	(0.22)
PEER	−7.941	−1.021	−0.314
	(0.40)	(3.11)	(1.31)
BOARD	0.395	0.054	0.645
	(0.40)	(0.09)	(1.58)
SIZE	0.674	0.490	0.010
	(2.99)	(3.95)	(0.12)
WEALTH	0.511	0.539	−0.018
	(1.60)	(2.86)	(0.13)
YEARS	−0.130	−0.327	−0.098
	(0.28)	(1.23)	(0.51)
REPORT	−0.669	−0.218	0.015
	(1.13)	(0.74)	(0.07)
TIME	1.134	1.396	0.701
	(1.06)	(2.35)	(1.63)
HOURS	−1.410	−1.007	−0.504
	(3.28)	(4.29)	(2.96)
p (model)	0.0001	0.0001	0.0147
Adjusted R^2	0.2403	0.2144	0.0525

The first equation suggests that quality is driven by many of the variables suggested by Deis and Giroux. Size, however, is omitted from the quality equation. The second equation indicates that the number of hours the auditor works is jointly determined with desired quality. Hours are hypothesized to be a function of desired quality, client size and wealth (*SIZE* and *WEALTH*), industry expertise (*CLIENTS*), experience with client (*TENURE*), and complexity or difficulty (*TIME*). Estimating these relations simultaneously with three-stage least squares results in the coefficients reported in our table 4.[6] Note that *HOURS* is driven by size, complexity (*TIME*), and quality. (Recall that high quality is represented by low measures of the *QUALITY* variable.) *QUALITY*,

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[6] Limited information maximum likelihood and two-stage least squares estimates are very similar and are not reported separately.

Table 4

Simultaneous-Equations Model for the Deis-Giroux Study

(Absolute t-statistics in parentheses)

$$QUALITY=\beta_0+\beta_1 TENURE+\beta_2 CLIENTS+\beta_3 PEER+\beta_4 BOARD+\beta_5 WEALTH+\beta_6 YEAR +\beta_7 REPORT+\beta_8 TIME+\beta_9 HOURS$$

$$HOURS=\phi_0+\phi_1 TENURE+\phi_2 CLIENTS+\phi_3 SIZE+\phi_4 WEALTH+\phi_5 TIME+\phi_6 QUALITY$$

Variable	*Quality*	*Hours*
INTERCEPT	−2.354 (1.68)	2.525 (3.19)
TENURE	0.017 (2.80)	0.000 (0.02)
CLIENTS	−0.025 (1.79)	−0.014 (1.40)
PEER	−0.566 (4.09)	— —
BOARD	0.223 (0.97)	— —
SIZE	— —	0.309 (11.06)
WEALTH	0.125 (1.57)	0.011 (0.20)
YEAR	0.002 (0.02)	— —
REPORT	−0.182 (1.46)	— —
TIME	0.553 (2.24)	0.428 (2.50)
HOURS	−0.090 (0.68)	— —
QUALITY	— —	−0.274 (1.97)

however, continues to be related to the variables hypothesized by the reputation-effects theory, peer review (*PEER*) and audit complexity (*TIME*), but is not as strongly driven by hours as inferred by Deis and Giroux.[7]

There are questions as to whether the data really support the two hypotheses of reputation effects and power conflict. DeAngelo (1981) defines audit quality as including both competence and independence. Deis and Giroux readily admit that their hypothesis tests consider only variables that impinge on independence and ignore issues of competence. This omission of potential explanatory variables can lead to biases in both the estimates of the coefficients and the corresponding standard errors.

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[7] This reexamination of the data with a simultaneous equations model points to the multiple meanings of constructs. In the *HOURS* model, *TENURE* and *CLIENTS* proxy for expertise. In the *QUALITY* model, these variables represent the reputation-effects argument.

There are also differences in emphasis that need to be considered in governmental auditing. Many governmental audits deal with compliance issues and are concerned with whether a reporting entity has utilized its resources according to statutes and specific legislative appropriations. This differs from the customary emphasis on faithful representation in audits of commercial enterprises (i.e., whether the financial statements fairly represent the financial position of a firm). This suggests that the factors that make for a "quality" audit may differ between the private and governmental sectors. It is not obvious, therefore, that the associations Deis and Giroux find in their study carry over into audits of commercial firms or that all the relevant variables have been incorporated appropriately in their analysis. Further, as we shall see in the next section, there are many issues in governmental auditing outside the scope of the matters studied by Deis and Giroux.

III. Other Avenues for Research

The articles by Feroz and Wilson and Deis and Giroux are welcome additions to the sparse coverage of topics in governmental accounting and auditing in *The Accounting Review*.[8] Major developments that have been occurring in these areas invite research attention. Guidance for municipal accounting was previously provided by periodic update of the "blue book" (*Governmental Accounting, Auditing and Financial Reporting*) by the National Council on Governmental Accounting (NCGA) under the sponsorship of the Municipal Finance Officers Association. This has been supplanted with continuing attention to governmental accounting problems by the GASB.[9] The Federal Accounting Standards Advisory Board (FASAB 1991), partly in response to the Chief Financial Offices Act of 1990, has articulated its objectives in the preface to its exposure draft entitled *Financial Resources, Funded Liabilities and Net Financial Resources of Federal Entities:*

> The Board plans to identify users' information needs, articulate objectives of federal accounting and reporting, and determine the accounting principles needed to satisfy various information needs. Each of these steps will require varying degrees of research and deliberation. Results of the research will provide a basis for developing a conceptual overview for federal accounting and reporting and will assist the Board in developing accounting standards.

The magnitudes involved are huge, and the issues to be addressed are important. As we noted in our opening paragraph, state and local governments now account for some 11 percent of U.S. gross domestic product. The total of public expenditures, which includes federal as well as state and local government, approaches 40 percent of gross domestic product. With the addition of the closely related area of not-for-profit activities and entities,[10] the total tops out at well over 40 percent.

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[8] We are grateful to M. Granof and S. Y. Lee for helping us through the last five volumes of *The Accounting Review*. We located only four articles that dealt with governmental accounting and two more that addressed not-for-profit accounting.

[9] The NCGA identified the overall goals of governmental accounting as providing information useful for (1) making economic, political and social decisions, (2) demonstrating accountability and stewardship, and (3) evaluating managerial and organizational performance. Its successor, the GASB, also recognized that uses of external financial reporting of governmental units consist of (1) comparing actual financial results with the legally adopted budget, (2) assessing financial condition and results of operations, (3) assisting in determining compliance with the finance-related laws, rules and regulations, and (4) assisting in the evaluation of efficiency and effectiveness.

[10] We will not address the research issues of not-for-profit entities. A summary regarding management and accountability may be found in Drucker (1990), and a description of current budgeting and accounting practices may be found in Anthony (1991).

Responses from other disciplines have been forthcoming in forms which include the development of PPBS (program, planning, budgeting systems) by the economics division of the RAND Corporation. As described in Cheek (1977, 8–11), these have stimulated further developments like those represented by ZBB (zero-base budgeting) and MBO (management by objectives)—all of this being done without any contributions by accounting researchers that we have been able to discover.[11]

Continuing this evolution to broadened realms of accountability, GASB has recently issued a research report which is also a call to research entitled "Service Efforts and Accomplishments Reporting: Its Time Has Come" with a foreword by M. Ives, its Director of Research, from which we excerpt the following:

> The GASB believes that SEA [Service Effort Accomplishment] will become a major element of governmental financial reporting, assisting in fulfilling government's duty to be publicly accountable and in enabling citizens, elected officials and other users of financial reports to assess that accountability. . . . The researchers [in this report] identify four types of SEA indicators (input, output, outcomes and efficiency) but tend to emphasize the more complex ones: outcomes and efficiency. This is because the outcomes and efficiency indicators—relating efforts to accomplishments—are useful not only in accounting for the past, but also in planning for the future. They help answer some of the fundamental questions of state and local government: How much better off might the citizenry be as a result of specific increases in resources for a particular activity? What are the tradeoffs (in terms of likely outcomes) from applying an expected decline in resources to one activity as compared with another (p. iii).

If governmental accounting is described as being in a state of rapid evolution, one would have to use a term like "revolutionary" to characterize the developments initiated in the 1960s by the U.S General Accounting Office (GAO). According to Elmer Staats, the former comptroller general, these developments were undertaken when it was found that the financial audits used by his predecessor were not adequate for Congress and the public once the "Great Society" programs of Lyndon Johnson were launched.

Still referred to as "GAO-type audits," these audits have a variety of other names, such as performance audits, management audits, value-for-money audits,[12] and comprehensive audits. By whatever name, these audit concepts and practices have now spread to state governments and to governments in other parts of the world. They have also affected the conduct of internal audits in private industry and practices in public accounting, as reflected in the management audits sometimes conducted for public utility commissions.

The revolutionary nature of these auditing developments can perhaps best be indicated by noting the reversal that occurs in management-auditor relations. In customary financial audits, which are also stylized as "attest audits," auditors review the representations that management intends for the audiences it selects (usually the financial community). In comprehensive audits, the situation is reversed, and the auditor selects the area of management activity to be examined as well as the audiences to which the results are to be reported. Management is then given an opportunity to attest or take exception to all or parts of what is reported, with comments that are (or should be) incorporated in the audit's report prior to its release.[13]

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[11] There have, however, been studies (see, e.g., Patillo 1977) undertaken by organizations like the National Association of Accountants to describe and (to some extent) evaluate some of these developments.

[12] This name was apparently coined by J. J. Macdowell when he was auditor general of Canada. He subsequently changed it to "comprehensive audits," which appears in the title of the Comprehensive Audit Foundation that he helped organize. For further details, see the discussion under the term "audit" in *Kohler's Dictionary for Accountants* (Cooper and Ijiri 1983).

These new types of audits may take various forms and focus on various issues. According to Churchill et al. (1977), the issues may be classified in terms of (1) propriety (of objectives and methods), (2) effectiveness (ability to state and achieve goals), and (3) efficiency (benefits achieved, resources used). It is possible to cover all three areas in a single audit, as was done by the GAO in its examination of the FBI's domestic surveillance activities in the 1960s. These activities were found to be improper in their objectives (no constitutional or legal authority) and methods (use of wiretaps without court authorization) as well as ineffective (no clear statement of goals and no achievements of note) and inefficient (few benefits and excessive expenditures).[14]

From the standpoint of ordinary financial audits, all this might seem farfetched. But this response overlooks challenges and opportunities that might be involved in exploring possibilities and locating boundaries for such expanded-scope audits.[15] Even the GAO audit of the FBI, for instance, suggests possible uses for such audits in objectively as well as completely evaluating and guiding local police activities (in contrast to the usual reviews by internal affairs divisions of the same departments). This is a topic that should be of interest for research, at least in governmental accounting and auditing.

This orientation toward improvement of practice is not unknown in respected circles of research. Economics proved responsive, for example, in developing the tools and concepts that are associated with cost/benefit and cost/effectiveness analyses. Other related disciplines, like management science and operations research, have also been responsive in a variety of ways. Data envelopment analysis,[16] for example, was developed in response to the need for evaluating activities such as the "Program Follow Through" experiment in U.S. public schools. The experiment involved multiple outputs and inputs without any "bottom line" being evident; also, unknown and complex interrelations between program components placed severe strains on customary regression, correlation, and ratio approaches.

IV. Concluding Remarks

In closing, we do not want to leave an impression of blaming *The Accounting Review* for lacunae in the research activities reported in its pages. Like any journal of scientific research, the *Review* must be responsive, in large part, to what researchers supply and demand. Researchers in accounting, it seems, have not been responsive to the problems and opportunities associated with developments in governmental accounting. Deficiencies in the preparation of researchers, as noted in a recent editorial by Burton and Sack (1991), have not been confined to the areas of governmental accounting and auditing.[17]

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[13] This is standard GAO practice, but it is not always followed. For instance, a report issued in July 1991 by the Office of the Texas Comptroller of Public Accounts recommends sunsetting the TEA (which issues the ratings cited by Deis and Giroux) but did not provide TEA with an opportunity to respond to the findings or recommendations contained in the report.

[14] For further discussion see Churchill and Cooper (1978).

[15] See the discussion in Burton and Fairfield (1982).

[16] See Banker (1989) and Banker et al. (1989b) for an introduction to data envelopment analysis from the perspectives of econometric and operations research.

[17] See also Cooper and Zeff (1992).

Our examples from other disciplines that have been responsive to these needs and opportunities might be regarded as slanted toward a heavy emphasis on methodology as in econometrics or management science. Alternatives to such an emphasis might be considered, however, and need not involve any serious abandonment of what has already been accomplished in present programs for Ph.D. preparation in accounting. One possibility is to develop a research agenda that ensures that use is made of results from base disciplines in a sufficiently rapid manner or, even better, in a way that influences these disciplines in directions that promise to be of use. This can be done, as has already been demonstrated, by interactions between statistics and auditing research.[18] Another alternative is to encourage work with persons in other disciplines who are capable of developing new methods or modifying existing ones in response to what is needed to address accounting issues.

Still other alternatives might be suggested, but the main desiderata lie in the development of attitudes that will encourage accounting researchers to respond to problems in the profession and practice of auditing and accountancy. Without this attitude, the ability to communicate and interact with others in disciplines such as statistics, operations research, economics, psychology, and computer science is likely to reinforce rather than remedy the kinds of deficiencies in research attention that we have been examining.

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[18] There has even been a National Research Council study on this topic. See *Statistical Models and Analysis in Auditing*, prepared for the National Research Council Board of Mathematical Sciences by the Committee on Applied and Theoretical Statistics (NRC 1988).

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Budgetary Participation and Managerial Performance: The Impact of Information and Environmental Volatility

Leslie Kren
University of Wisconsin–Milwaukee

SYNOPSIS AND INTRODUCTION: Organizational theorists have posited a positive relationship between employee performance and participation in budgeting or goal setting (Argyris 1952; Becker and Green 1962). In examining this proposition, empirical research has studied the motivational and cognitive mechanisms by which participation may be related to employee performance (Locke et al. 1986; Murray 1990). Cognitive mechanisms include factors such as the acquisition and use of information and comprehension of job requirements (Locke et al. 1986).

Kren and Liao (1988) argue that empirical accounting research has generally focused on the motivational effects of participation. In general, results have been mixed (Murray 1990). While Merchant (1981) found a positive relationship between motivation and participation, Brownell and McInnes (1986) did not find such a relationship. The results prompted Brownell and McInnes to suggest that future research should examine performance benefits of participation that are not mediated by motivation.

Recently, accounting researchers have studied the role of cognitive factors in explaining the relationship of participation to performance. Chenhall and Brownell (1988), for example, found that budgetary participation provided information that reduced role ambiguity that contributed to improved performance, and Mia (1989) found the relationship between participation and performance to be moderated by job difficulty.

The objective of this article is to examine the perceived level of job-relevant information as an intervening variable between budgetary participation and individual performance. Job-relevant information (JRI) is information that facilitates job-related decision making. The results of this

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study, based on a questionnaire survey of division managers in large corporations, suggest that participation affects performance, not directly, but through JRI. In addition, this positive performance effect of participation persists and is more pronounced when environmental volatility is high, although the results do not provide unambiguous evidence.

Key Words: *Participation, Budgeting, Environmental volatility, Cognitive effects.*

Data Availability: *Data are available from the author upon request.*

THE remainder of this article is organized as follows. The next section discusses the role of JRI as an intervening variable between budgetary participation and individual performance. The effects of environmental volatility are also discussed. Subsequent sections contain a description of the research method, an analysis of the results, and a summary and conclusion.

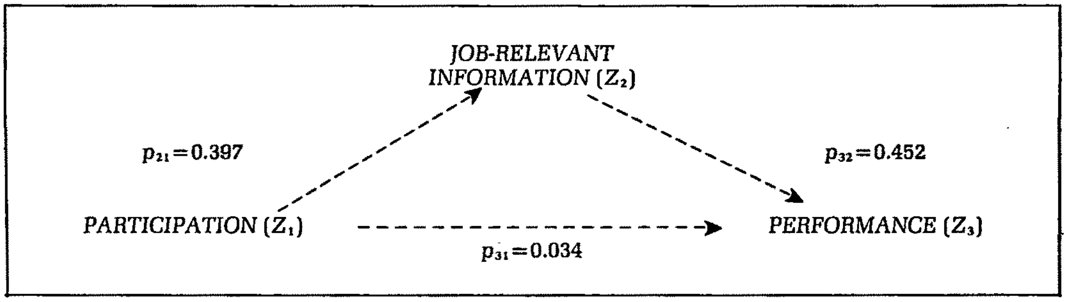
I. Job-Relevant Information as an Intervening Variable

The accounting literature (Baiman 1982; Baiman and Demski 1980; Tiessen and Waterhouse 1983) has identified two primary types of information in organizations: decision influencing, which is collected about a manager's behavior for the purposes of performance evaluation; and JRI, which helps a manager to improve his or her action choice through better-informed effort. The latter provides the manager with a better understanding of decision alternatives and actions needed to reach objectives (Locke et al. 1986). JRI has also been called decision-facilitating (Demski and Feltham 1976) and *ex ante* information (Baiman 1982; Tiessen and Waterhouse 1983). Most accounting information in the organization is of one or the other type.

In most budgetary situations, environmental factors, managerial skills, and effort jointly determine performance (Chalos and Haka 1990). JRI can improve performance because it allows more accurate predictions of environmental states and thus allows more effective selection of appropriate courses of action. Campbell and Gingrich (1986) provided evidence supporting the positive performance effects of JRI. In their experiment, some programmers actively participated in discussing new project assignments with their superiors and jointly determined their completion targets. Objectives of equal difficulty were assigned to other programmers. The participating programmers significantly outperformed the other programmers for complex but not for simple projects. Campbell and Gingrich concluded that participation in setting goals led to task discussions with another expert (the superior) that allowed programmers to gain specific insights into more effective approaches to complex projects. When projects were simple, however, effective task procedures may have been so obvious such that discussions with superiors provided few insights and had little effect on performance.

Budgetary participation can similarly facilitate the acquisition and use of JRI. Since participation provides an opportunity to influence the budget before it is finalized, in preparing a participatory budget, a manager must generally assume a more active role. Thus, the manager becomes more involved in considering and evaluating alternative budget goals. Participation may thus increase the manager's attempts to formulate ac-

Figure 1
The Research Model



Note: The subscripts 1, 2, and 3 refer to the variables of participation, *JRI*, and performance, respectively. The path coefficients (p_{ij}) indicate the effect of variable j in explaining the variation in variable i.

curate forecasts of environmental states and can focus the manager's attention on decisions and behaviors needed in future periods. It may also increase the time spent thinking about budgetary objectives and alternative means-end approaches (Earley et al. 1987; Lawrence and Lorsch 1967; Locke et al. 1986). As a consequence, budgetary participation can create an environment that encourages the acquisition and use of JRI. Results of field research provide supporting evidence (Lowe and Shaw 1968; Simons 1987) as does the research on budget-related behaviors (Merchant 1984). Simons' (1987) field study of the Johnson & Johnson Company provides detailed descriptions of how budgetary participation promotes extensive JRI search activities by managers, and these activities appear to occur primarily because the budgetary process is participatory rather than imposed.

Several sources of JRI are available to the manager, including the external environment (i.e., environmental scanning [see Bourgeois 1985]) and peers, subordinates, and superiors (Hopwood 1976). Earlier research suggests that a manager's superior is an effective information source in most organizations, particularly when superiors have extensive company-specific experience, as in the case of companies that routinely promote from within (Simons 1987).

Two recent studies have examined the effects of cognitive factors associated with JRI. Mia (1989) proposed that perceptions of job difficulty moderate the relationship between budgetary participation and performance because participation provides valuable information for difficult jobs. Surveying middle-level managers, Mia found a positive relationship between participation and performance only when job difficulty was high.

Chenhall and Brownell (1988) have suggested that role ambiguity links budgetary participation and performance. In a survey study, they found that participation reduced role ambiguity, which improved performance. JRI and role ambiguity are similar constructs in that the latter reflects the extent to which managers understand their duties and responsibilities, while the former is a measure of the information available to managers to accomplish job-related tasks.

The schematic structure in figure 1 suggests that participation has an indirect effect on performance through JRI. Participation is expected to increase JRI initially, which would in turn improve performance. Thus, JRI serves as the link between participation and individual performance, suggesting the following hypothesis:

H1: The relationship between budgetary participation and managerial performance will be explained by an indirect effect whereby participation increases job-relevant information, and job-relevant information is positively associated with performance.

The Effects of Environmental Volatility

In describing the organization's external environment, organizational theorists (Downey and Slocum 1975; Duncan 1972; Tosi et al. 1973) have generally included two components: (1) diversity, the range of environmental factors faced by an organization and (2) volatility, the change or variability among these factors. Leblebici and Salancik (1981) argued that diversity is more predictable because it can be evaluated and anticipated. Thus, it can be managed using institutionally formalized procedures (i.e., by "disentangling the pieces," as in market segmentation [p. 583]). Volatility, however, is stochastic in nature and cannot be easily anticipated; managers make inferences about effects of probabilistic environmental factors on cause and effect relationships. JRI can be used to improve such predictions. Thus, one would expect that volatility would affect the information-gathering activities of managers (Bourgeois 1985; Hopwood 1976). Leblebici and Salancik (1981), for example, found that bank loan officers sought more information when making loan decisions when the environment is volatile.

In a budgeting setting, volatility is expected to positively affect: (1) the level of budgetary participation, (2) the link between participation and JRI, and (3) the link between JRI and performance. When volatility is low, few exceptions occur and rules and procedures are adequate to specify behaviors. Managers can also rely more readily on insights gained from previous experience. As volatility increases, however, numerous exceptions can overwhelm the information system unless decisions are made at lower hierarchical levels in the organization (Galbraith 1973; Simons 1987). Consequently, greater participation in decision making by lower-level managers is required. Govindarajan (1986) and Hopwood (1976) extended this reasoning about participation in decision making in general to participation in budgeting, suggesting that greater budgetary participation should be found in organizations facing greater volatility.

In addition, the link between participation and JRI is expected to become stronger when volatility is high because managers are expected to take greater advantage of participation to acquire JRI for effective decision making (Tung 1979). The link between JRI and performance is also expected to become stronger when volatility is high because volatile environments require managers to make maximum use of all available information to deal with more difficult decision settings (Leblebici and Salancik 1981; Tung 1979). When volatility is low, in contrast, more decisions are routine and some JRI may not be needed to carry out job functions because rules and procedures may be adequate for effective job performance, which is the second hypothesis:

H2: When volatility is high, three effects on the model proposed in hypothesis H1 (fig. 1) will result:

H2a: the level of participation will increase,

H2b: the link between participation and JRI will be stronger, and
H2c: the link between JRI and performance will be stronger.

II. Research Method

Sample

Data for this study were collected by using a questionnaire survey of profit center managers from *Fortune 500* manufacturing firms. The listing for each *Fortune 500* firm in the Dun and Bradstreet *Reference Book of Corporate Managements* was examined, and executive-level profit center managers at the hierarchical level immediately below the CEO were identified. A sample of profit center managers was contacted to ensure that they have budgetary responsibility.

A maximum of two managers in a firm were randomly selected for inclusion in the sample to allow for more company representation. Companies listed in the directory were excluded if profit center managers could not be clearly identified from their job titles. This selection process yielded 192 managers from 96 companies. A cover letter and a questionnaire were mailed to each manager. A follow-up letter and another copy of the questionnaire were sent after approximately three weeks. After several additional weeks, all remaining nonrespondents were contacted by telephone.

Follow-ups of the original 192 managers revealed that 38 had retired, left the company, or had changed to new positions. Of the remaining 154 potential respondents, 80 usable responses were received (a response rate of 51.9 percent) from 63 different companies. Responses were obtained from two managers in each of 17 companies. Respondents were promised anonymity, but organizational affiliation was tracked to allow measurement of environmental volatility. Respondents' average tenure in their positions was 4.8 years (s.d. = 3.3). Appendix A provides a listing by industry (as defined by four-digit SIC code) of the final sample.

Measures

Appendix B contains an abbreviated copy of the research questionnaire used to measure the self-reported variables in this study.

Performance. Because of the promise of respondent anonymity, a self-rated measure of performance was used. Managers were asked to rate themselves on eight dimensions of performance identified by Mahoney et al. (1965): planning, investigating, coordinating, evaluating, supervising, staffing, negotiating, and representing. An overall item was also included (item 9).

The Mahoney et al. measure has been used effectively in previous studies of budgetary participation (e.g., Brownell and McInnes 1986; Govindarajan 1986). Although the potential for bias (higher mean values in comparison with objective performance measures) exists with a self-rating of performance, it may not be consequential since there is no reason to suspect a systematic relationship with the independent variables.

According to Brownell and McInnes (1986), this performance measure should meet two criteria: (1) reasonable assessment of independent dimensions of performance, and (2) the majority of the variation in the overall rating (item 9) should be explained by the eight items. Regressing the overall rating as the dependent variable on the ratings of each of the eight individual dimensions resulted in 75.6 percent explained variation, suggesting that the second criterion was met. To meet the first criterion of independence, Brownell and McInnes assert that pair-wise correlations between the eight variables should be less than the correlation of each variable with the overall rating. Only four of the 28 comparisons violated this criterion. Thus, the measure appears to encompass reasonably independent dimensions of performance that are correlated with the overall measure. To capture a uni-dimension of performance, the eight sub-scale items were summed up to construct a composite performance scale. The combined scale was significantly correlated ($r=0.840$; $p<0.01$) with the overall rating (item 9).

Budgetary Participation. This variable was defined as the manager's degree of influence on the budget. A three-item version of a participation measure employed by Milani (1975) was used. (This measure is similar to the scale of participatory decision making used by Abdel-halim and Rowland [1976] and is based on Vroom [1960] and Vroom and Mann [1960].)

A factor analysis of the scale revealed only one factor with an eigenvalue greater than 1, which explained 76.9 percent of the total variance indicating that only one construct was being measured. The reliability coefficient computed for the scale in this study was 0.85. An overall measure of budgetary participation was constructed by summing up responses to the three individual items.

Job-Relevant Information (JRI). The objective of this measure is to assess the extent to which managers perceived information availability for effective job-related decisions. Managers with adequate JRI are expected to perceive and report that they have adequate information to accomplish their job-related objectives and to evaluate important decision alternatives.

Based on O'Reilly's (1980) information overload index, a scale was developed for use in this study, with the wording modified to fit the context of this study (Roberts and O'Reilly 1974). Several colleagues, working managers, and executive MBA students with relevant work experience were asked to comment on the scale and concurred on its face validity.

Factor analysis confirmed the single-factor structure of the scale. Only one factor was present with an eigenvalue greater than 1 explaining 64.3 percent of the total variation. The reliability coefficient calculated for the scale was 0.72. For subsequent analysis, the items were summed up.

Environmental Volatility. For this study, volatility is defined as change or variability in the organization's external environment (Tung 1979). Previous studies of environmental volatility have focused on variability of accounting variables (e.g., sales or income) at the industry level. Tosi et al. (1973) argue that more stable patterns in such measures across time indicate more stable environments and thus are easier to predict (Bourgeois 1985).

Tosi et al. operationalized volatility by using the following three variables: (1) market volatility, the coefficient of variation of net sales; (2) technological volatility, the coefficient of variation of the sum of research and development and capital expenditures divided by total assets; and (3) income volatility, the coefficient of variation of profits before taxes (used as a composite measure to capture other sources of volatility). The measures were further verified by Snyder and Glueck (1982). The coefficient of variation (the variance is standardized by the magnitude) is used because it allows comparisons across industries of different sizes.

In a later study, Bourgeois (1985) suggested using first differences of the Tosi et al. measure. Bourgeois argued that a high but constant, and thus predictable, rate of change could produce a high coefficient of variation. However, it is not only the rate of change that creates volatility, but also the unpredictability of the change (Downey and Slocum 1975; Milliken 1987). Bourgeois argued that the coefficient of variation of first differences provides a better measure of discontinuities. Thus, for this study, market, technological and income volatility were measured by using first differences as follows:

$$\text{volatility } (X_i) = \frac{\sum_{j=1}^{n} CV(X_i)_j}{n},$$

where X_i = market, technological, or income variable and n = number of companies in the industry (not including the sample company) and,

$$CV(X_i) = \frac{\sqrt{\sum_{k=1}^{5} \frac{(Z_k - \bar{Z})^2}{5}}}{\bar{Z}},$$

where $Z_k = (X_{i,k} - X_{i,k-1})$, and $X_{i,k}$ = market, technological, or income variable in year k.

For each firm in the sample, industry-level statistics were calculated by using all other companies listed on Standard and Poor's COMPUSTAT data file with the same two-digit SIC code. In conformance with previous research, industry-level measures were used because they seem most relevant to the key dimensions of a company's external environment (Bourgeois 1985; Tosi et al. 1973; Tung 1979). The industry-level measure used in the analysis to be shortly presented was also significantly correlated with a correspondingly calculated company-level measure ($r = 0.321$; $p < 0.05$).

Factor analysis of the three resulting variables revealed only one factor with an eigenvalue greater than 1 (explaining 68.1 percent of the total variance), which indicates that only one construct was measured. Thus, the three variables were summed up to provide an overall measure of volatility.

Of the 63 companies in the sample, 17 were significantly diversified conglomerates or obtained more than 20 percent of their total revenues from unrelated operations as indicated by segment disclosures in annual reports. Because it was difficult to identify an appropriate industry reference group for these diversified companies, the analysis of volatility effects excluded these 17 companies (representing 21 respondents). Thus, for subsequent analysis of volatility effects, the sample size was reduced to 59.

III. Analysis and Results

Table 1 provides descriptive statistics for the measured variables in the study. Although the participation measure is skewed (the mean is near the top of the variable's range), the managers in this sample were at the highest level of the corporate hierarchy, suggesting that participation might be high (Searfoss and Monczka 1973). Intercorrelations between the measured variables are shown in table 2. The significant, zero-order correlation between participation and JRI ($r = 0.397$; $p < 0.01$) is consistent with hypothesis H1, as is the correlation between JRI and performance ($r = 0.466$; $p < 0.01$). To interpret the latter coefficient in the context of hypothesis H1, however, a path-analytic approach is used. The zero-order correlation between budgetary participation and per-

Table 1
Descriptive Statistics for Measured Variables
($n=80$)

Variable	*Hypothetical Range*	*Actual Range*	*Mean*	*Standard Deviation*
Participation	3–21	8–21	18.2	3.0
Information	3–21	9–21	15.9	3.0
Volatility ($n=59$)	na	8.9–23.2	15.7	3.6
Performance	8–56	34–56	45.0	4.7

Table 2
Correlation Matrix for Measured Variables
($n=80$)

Variables	2	3	4
1. Volatility ($n=59$)	−0.044	−0.122	0.032
2. Participation	—	0.397*	0.214
3. Information		—	0.466*
4. Performance			—

* Significant at $p<0.01$ (two-tailed test).

formance ($r=0.214$; $p<0.07$) is weakly significant, which will be explained more clearly by participation's effects on JRI.

Participation, JRI, and Performance

Hypothesis H1 posits that JRI will act as an intervening variable to explain the relationship between budgetary participation and managerial performance. This hypothesis is tested by using the path analysis model summarized in figure 1.[1]

Each path coefficient, p_{ij}, indicates the impact of variable j in explaining the variance in variable i. The values of the path coefficients can be interpreted in units of standard deviation. For example, the path coefficient of $p_{21}=0.397$ in figure 1 indicates that for every standard deviation increase in the participation measure, the data predict a 0.397 standard deviation increase in JRI.

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[1] Path analysis is an application of regression and correlation appropriate for estimating a series of interrelated parameters (Wonnacott and Wonnacott 1981). It allows statistical analysis of the direct contribution of participation to performance and its indirect contribution through JRI. This is accomplished by estimating the values of the path coefficients designated p_{ij} in figure 1.

A series of regressions are used to estimate the path coefficients, according to the following,

$$Z_2 = p_{21} Z_1, \tag{1}$$

$$Z_3 = p_{31} Z_1 + p_{32} Z_2, \tag{2}$$

where, Z_1 is the measure of participation, Z_2 is JRI, and Z_3 is performance. Each variable is standardized to a mean of zero and a standard deviation of 1.

The path coefficients also can be used to decompose the total relationship between two variables (i.e., performance and participation) into direct and indirect effects (i.e., through JRI). The total relationship can be measured with the zero-order correlation coefficient, r_{ij}. Thus,

$$r_{12} = p_{21}; \tag{3}$$

$$r_{23} = p_{32} + p_{31} r_{12}; \tag{4}$$

$$r_{13} = p_{31} + p_{32} r_{12}. \tag{5}$$

The subscripts 1, 2, and 3 refer to the variables of participation, JRI, and performance, respectively (see fig. 1). The first term on the right-hand side is an estimate of the direct effect (the path coefficient), or the effects through unobserved intervening variables. The second term is an estimate of the indirect effect or, in the absence of predicted indirect effects, the second term provides an estimate of spurious effects. Thus, for this study, equation (4) allows decomposition of the total relationship between JRI and performance (r_{23}) into a direct effect (p_{32}) and a spurious effect ($p_{31} r_{12}$). The spurious effect results from participation, which is a common antecedent of both JRI and performance. Equation (5) allows decomposition of the total relationship between participation and performance (r_{13}) into a direct effect (p_{31}) and the indirect effect through JRI ($p_{32} r_{12}$). Hypothesis H1 posits that the indirect effects of participation through JRI, will predominate.

The results of estimating equations (1) and (2) for the total sample are shown in table 3 and figure 1. The direct path between participation and performance (p_{31}) was not, as expected, statistically significant. However, the path coefficients between participation and JRI (p_{21}) and between JRI and performance (p_{32}) were significant at conventional levels. Both regression models were significant, also at conventional levels.

The decomposition of the linkages in the model (eqs. [3], [4], and [5]) is shown in table 4. The prediction of hypothesis H1 was that most of the effect of participation on performance would be indirect (through JRI) with little direct effect. The results shown in table 4 (eq. [5]) support this prediction. The direct effect of participation on performance (0.034) is small relative to the indirect effect through JRI (0.180). Thus, for every standard deviation increase in participation (eq. [3]), JRI increases by 0.397 standard deviation, and for every standard deviation increase in JRI (eq. [4]), performance increases by 0.466 standard deviation. In total, for every standard deviation increase in participation, performance increases by 0.180 standard deviation. In addition, only a small portion of the relationship between information and performance (eq. [4]) is spurious (0.014) relative to the direct effect (0.452). Overall, the results are consistent with hypothesis H1.

Table 3
Results of Path Analysis

Dependent Variable/ Link to	*Path Coefficient (Fig. 1)*	*Total Sample (n=80)*		*High Volatility (n=30)*		*Low Volatility (n=29)*	
		Estimate	*t-statistic*	*Estimate*	*t-statistic*	*Estimate*	*t-statistic*
Equation (1):							
Information/ Participation	p_{21}	0.397	3.77**	0.442	2.61*	0.252	1.30
Equation (2):							
Performance/ Information	p_{32}	0.452	4.06**	0.606	3.60**	0.607	3.50**
Performance/ Participation	p_{31}	0.034	0.31	0.029	0.17	−0.121	−0.71

Note: For equation (1) (Information): total sample, R-square=0.158, F=14.24**;
high volatility, R-square=0.195, F=6.80*;
low volatility, R-square=0.063, F=1.69.

For equation (2) (Performance): total sample, R-square=0.218, F=10.44**;
high volatility, R-square=0.384, F=8.41**;
low volatility, R-square=0.339, F=6.15**.

* Significant at $p<0.05$ (two-tailed test).
** Significant at $p<0.01$ (two-tailed test).

The Effects of Environmental Volatility

Hypothesis H2 posits that when volatility is high, (1) the level of participation will be higher, (2) the link between participation and JRI (p_{21}) will be stronger, and (3) the link between JRI and performance (p_{32}) will be stronger. As described above, volatility effects were examined with a reduced sample size of 59 to eliminate diversified companies from the sample.

To examine hypothesis H2a, the zero-order correlation between volatility and participation was calculated. As shown in table 2, the correlation was not significant. Thus, the data do not support hypothesis H2a; managers did not report greater participation as volatility increased. The implications of this finding become clearer as the two remaining predictions are examined below.

To examine the effects of volatility on the link between participation and JRI and between JRI and performance, the sample was split at the median of the volatility measure and the path coefficients in figure 1 were recalculated for the two subsamples. The results of estimating equations (1) and (2) at high and low levels of volatility are shown in table 3 and in figure 2. As with the total sample, the direct path linkage between participation and performance (p_{31}) is not statistically significant at either high or low levels of volatility. In fact, the point estimate is negative at the low level of volatility.

Consistent with hypothesis H2b, the path coefficient between participation and JRI (p_{21}) is statistically significant at the high, but not at the low, level of volatility. Combined with the finding that managers did not participate more as volatility increased,

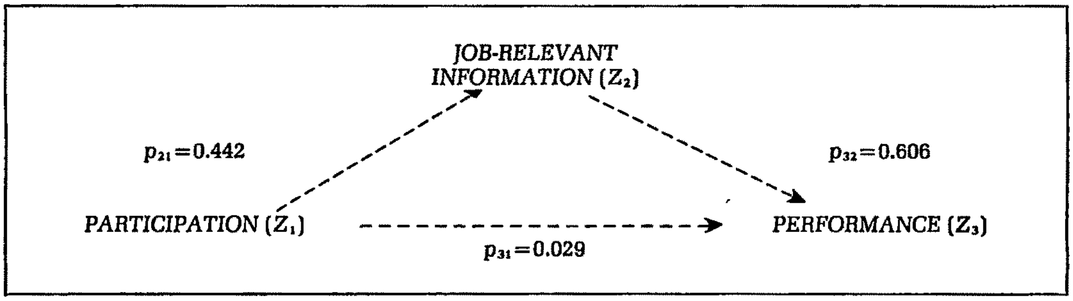
Table 4
Decomposition of Path Analysis Model Relationships

Dependent Variable/ Link to	Total Sample (n=80) Total Effect r_{ij}	Total Sample (n=80) Direct Effect p_{ij}	Total Sample (n=80) Indirect/ Spurious Effect	High Volatility (n=30) Total Effect r_{ij}	High Volatility (n=30) Direct Effect p_{ij}	High Volatility (n=30) Indirect/ Spurious Effect	Low Volatility (n=29) Total Effect r_{ij}	Low Volatility (n=29) Direct Effect p_{ij}	Low Volatility (n=29) Indirect/ Spurious Effect
Equation (3):									
Information/ Participation	0.397	0.397	—	0.442	0.442	—	0.252	0.252	—
Equation (4):									
Performance/ Information	0.466	0.452	0.014[a]	0.619	0.606	0.013[a]	0.570	0.607	−0.037[a]
Equation (5):									
Performance/ Participation	0.214	0.034	0.180[b]	0.297	0.029	0.268[b]	0.030	−0.121	0.151[b]

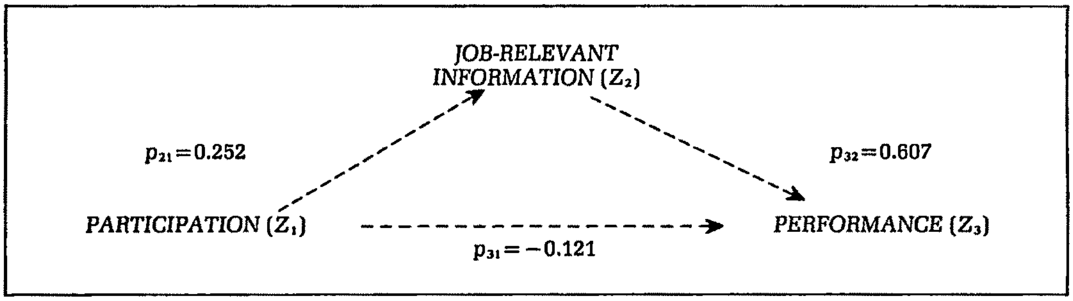
[a] Spurious effect.
[b] Indirect effect.

Figure 2
Research Model at High and Low Levels of Environmental Volatility

Panel A. High Volatility:



Panel B. Low Volatility:



this is consistent with the proposition that participation was used more effectively to acquire JRI when volatility was high. However, a general linear test (Neter and Wasserman 1974) indicates that the path coefficients (p_{21}) at the two levels of volatility are not significantly different from each other ($F_{2,55}=1.12$), so the support for hypothesis H2b is ambiguous.

The results do not support hypothesis H2c that the link between JRI and performance would be stronger at the high level of volatility. The path coefficients between JRI and performance (p_{32}) are highly significant at both levels of volatility and are not significantly different from each other, which indicates that, contrary to expectations, the relationship between JRI and performance is unaffected by the level of volatility.

The decomposition of the model linkages (eqs. [3], [4], and [5]) for high and low levels of volatility is shown in table 4. At both levels, the indirect effect of participation on performance through information is greater than the direct effect (eq. [5]). When volatility is high, the indirect effect of participation (0.268) is greater than the corresponding indirect effect when volatility was low (0.151). This is consistent with expectations that participation would be more strongly associated with performance when it is more useful in providing JRI, as when volatility is high. Once again, however, strong evidence of volatility effects is not present because estimates of the regression model in equation (2) are not significantly different across levels of volatility ($F_{3,53}=0.70$).

IV. Summary and Conclusions

The objective of this study was to examine JRI as an intervening variable in explaining the relationship between budgetary participation and individual performance. The results are consistent with the proposition that budgetary participation facilitates JRI acquisition by managers, and that JRI, in turn, is associated with improved performance. This study and other recent research support the view that the cognitive effects of participatory budgeting may be more consistent determinants of performance than the motivational effects (Brownell and McInnes 1986; Chenhall and Brownell 1988; Mia 1989). An important component of these cognitive effects appears to be related to JRI acquisition and use. In that regard, this study provides a link to the results reported by Mia (1989) and Chenhall and Brownell (1988). In both studies, the information effects of participation played an important conceptual role, as it did in this study. Furthermore, Brownell and McInnes (1986, 590) recognized explicitly that participation provided information to clarify the relationship between formal rewards and budget goals, which suggests another important information role for participation. Additional research is needed in this area, with consideration of job difficulty, role ambiguity, and reward system.

Overall, the effect of participation on performance, through JRI, persisted across the levels of environmental volatility and was somewhat more pronounced when environmental volatility was high, although more conclusive evidence is needed to confirm predictions about volatility effects. A larger sample may be needed, or a longitudinal study of organizations in transition in response to volatility changes.

Hypothesis H2a, which posited a positive relationship between volatility and participation, was not supported. This may indicate that organizations fail to recognize budgetary participation as an efficient means to increase the JRI available to managers. Alternate organizational mechanisms, such as enhanced management information systems, performance or process feedback (Early et al. 1990), or expert support staff may be more efficient responses to volatility. Also, organizations may sometimes fail to evaluate the level of volatility accurately which may contribute to inadequate responses to information needs (Bourgeois 1985).

Volatility had only marginal effects on managers' responses within the model (hyp. H2b and H2c). This may be a consequence of perceptual differences between managers in the high and low volatility groups. The former group may make greater efforts to acquire and use JRI, but since they face greater information processing demands, their perception of the level of JRI may not be greater than managers with more limited information needs. In addition, organizational budgetary systems may differ as volatility differs (Merchant 1984). Volatility could affect budgetary procedures through its effects on organizational factors and thereby affect JRI acquisition opportunities.

Several limitations of this study should be identified. Common-method bias from self-reported data may lead to overestimates of model relationships, particularly between the information and participation measures. Nonresponse bias may also have had unknown effects on the results. Another limitation, common to correlational studies, is that the results are open to alternate interpretations. Cross-sectional analysis does not provide clear-cut evidence to confirm predictions of causal relationships. For example, an alternate interpretation of the relationship between participation, JRI, and performance could be that well-informed managers perform better and are consequently allowed to participate more in budgeting. However, such an interpretation is inconsistent with conclusions of previous accounting research (Chenhall and Brownell 1988; Mia 1989) and studies in other disciplines (Campbell and Gingrich 1986). Campbell and Gingrich's results are based on a field experiment which provided better control over confounding variables and so give stronger support for predictions of causality.

Appendix A
List of Industries Included in the Sample

Industry	*Number of Companies*	*Number of Respondents*
Food and kindred products	3	4
Tobacco products	1	2
Lumber and wood products	1	1
Furniture and fixtures	1	1
Paper and allied products	8	11
Printing and publishing	1	2
Chemicals	13	17
Petroleum refining	1	1
Rubber and plastic products	2	4
Stone and concrete production	2	2
Primary metal industries	2	2
Metal fabrication	4	5
Commercial machinery	9	11
Electrical equipment	7	8
Transportation equipment	6	6
Photography equipment	2	3
Totals	63	80

Appendix B
Abbreviated Research Questionnaire

Participation

Q1. I am involved in setting all portions of my budget. (Response anchors: 1 = strongly disagree, 7 = strongly agree.)

Q2. My budget is not final until I am satisfied with it. (Response anchors: 1 = strongly disagree, 7 = strongly agree.)

Q3. My opinion is an important factor in setting my budget. (Response anchors: 1 = strongly disagree, 7 = strongly agree.)

Job-Relevant Information

Q1. I am always clear about what is necessary to perform well on my job. (Response anchors: 1 = strongly disagree, 7 = strongly agree.)

Q2. I have adequate information to make optimal decisions to accomplish my performance objectives. (Response anchors: 1 = strongly disagree, 7 = strongly agree.)

Q3. I am able to obtain the strategic information necessary to evaluate important decision alternatives. (Response anchors: 1 = strongly disagree, 7 = strongly agree.)

Appendix B—*Continued*
Abbreviated Research Questionnaire

Performance

Rate your performance as a manager on the following tasks. (Response anchors: 1 = below average performance, 7 = above average performance.)

1. Planning
2. Investigating
3. Coordinating
4. Evaluating
5. Supervising
6. Staffing
7. Negotiating
8. Representing
9. Rate your overall performance

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Cost Allocation in Multiagent Settings

Madhav V. Rajan
University of Pennsylvania

SYNOPSIS AND INTRODUCTION: Cost allocation is a pervasive practice in accounting. Horngren and Foster (1987, 411) define it as "the assignment and reassignment of a cost or group of costs to one or more cost objectives." An important form of cost allocation is the apportionment of corporate-level costs to various decentralized profit centers. The reason usually given for this procedure is that it is "a major means of getting subordinates to behave as desired by top managers" (1987, 422). Although such allocations have been criticized in the agency literature (Demski 1981) as being irrelevant for motivating managers in the presence of compensation contracts, this article identifies a precise role for indirect cost allocations, in conjunction with other instruments such as participative budgets, in settings with multiple divisions.

A survey by Fremgen and Liao (1981) showed that 84 percent of firms allocated at least part of their indirect costs to their profit centers, and 80 percent did so for the purpose of evaluating the performance of profit center managers. The major aim was to remind managers that indirect costs exist and that at least a portion of these costs had to be covered by profit center earnings. Further, Atkinson's (1987) poll reported that the primary objectives of allocating indirect costs were the motivation of employees and the provision of signals for resource allocation. There has been little analytical work, however, on the economic role played by cost allocation systems. Demski (1981) claims that allocation mechanisms are useful only if they provide additional information that can be contracted upon. Similarly, Baiman and Noel (1985) show that in certain multiperiod settings, it is optimal to compensate an agent on the basis of prior periods' realizations of costs that were not in the agent's control, provided these costs affect the principal's capacity decisions. Magee (1988) identifies conditions under which an agent is compensated according to the usage of some resource, in addition to output.

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The agency studies described above cannot address cost allocations *across* operating units since they do not model multiple productive divisions among which common costs are to be allocated. Further, because they model single-agent settings, the second-best incentive schemes they derive suffice to motivate managers efficiently; thus, there is no role for allocations unless they provide additional information to the owner. With multiple divisions, however, simple compensation contracts do not provide adequate incentives to guarantee the owner's desired outcome.

The role for allocations, over and above that of second-best contracts, in providing assurance to the owner is demonstrated here with a one-period model of an entrepreneur who incurs fixed costs in the production of different products by two workers. When the workers have correlated private information about the productivity of a common, central resource, the entrepreneur may fail to recover the fixed costs because the optimal payment schedules encourage the workers to misreport the productivity of the resource. By asking each worker to submit a budget to determine overhead rates, and by evaluating managers on their divisional profit after allocation of overhead costs, the entrepreneur can obtain the second-best return on the fixed investment. This mechanism is then compared to allocation systems observed empirically and to those recommended in the accounting literature.

The mechanism design approach pursued in this paper, with the game itself a variable, enables the study of procedures by which accounting numbers are derived for purposes of performance evaluation. The accounting system is not imposed as a monitor or source of information; its value arises from its procedures, which enable the owner to play off the managers' private information against each other to guarantee a second-best return on investment. In the absence of such a system, the division managers would gain from implicitly colluding in their use of the central resource. The allocation scheme coordinates their actions and induces them to act in the manner desired by the owner. This positive role for the allocation of indirect costs in conjunction with the budgetary process emphasizes the value of a cost allocation system as a set of linked motivational devices.

Key Words: *Multiple agents, Mechanism design, Budget process, Indirect cost allocation.*

Data Availability: *More detailed versions of all the proofs in the appendix are available from the author.*

THE correlated private information model presented here was introduced by Demski and Sappington (1984),[1] who identified the potential for implementation problems with second-best contracts as well as a costly solution, namely, strengthening the incentive constraint for one of the agents. Ma et al. (1988) proposed a solution that eliminated the problem at no cost to the owner, but their indirect mechanism involved a complex, asymmetric scheme in which one of the agents signalled probabilities in some unspecified manner. Also, neither study allowed for the communication of information from the agents to the owner,[2] which is crucial for modeling internal accounting systems. Providing a full characterization of optimal contracts when communication is introduced into the correlated-information model, I show the superiority of these contracts over previous incentive schemes and derive conditions under which the implementation problem extends to this centralized setting. I then demonstrate that a costless resolution to the implementation problem can be achieved in settings with communication by the use of a familiar accounting system, namely, budget-based cost allocation.

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[1] Studies that have subsequently used the correlated information model include Demski et al. (1988) and Smith and Hughes (1989), both of which examine whether the owner can achieve first-best results with risk-neutral agents, under various assumptions.

Suh (1987) shows that the use of one departments's stochastic direct cost in evaluating the performance of another department may be useful in preventing collusion between them. However, like the agency research mentioned earlier, Suh's study does not address the issue of allocating a common fixed cost across multiple divisions or derive any role for the procedures that characterize internal accounting systems in practice. Also, Suh's notion of collusion is based on cooperative game theory; that is, managers are assumed to be able to play nonequilibrium strategies with the aid of some unspecified exogenous mechanism (see Sarath 1987). In that framework, the one-way assignment of cost proposed as a solution to the collusion threat results in the use of a suboptimal contract and is costly to the owner. In contrast, I employ noncooperative game theory and show that indirect cost allocation systems are optimal economic mechanisms that can coordinate resource usage at no additional cost to the owner.

The presentation is organized into four sections. Section I details the model and the inability of second-best contracts to ensure the owner's recovery of fixed costs. Section II describes the cost allocation scheme proposed to solve this problem, the intuition behind its design, and the verification that it will indeed motivate the agents to report truthfully. In section III, various properties of the scheme are derived, and their implications are anlayzed. Section IV offers concluding remarks.

I. The Model and the Failure of the Second-Best Contracts

Consider an entrepreneur who sets up capacity at the beginning of a period to produce two different products at a manufacturing facility. There is a common, central resource necessary for the manufacture of both products. The total fixed cost incurred to operate the resource amounts to $\bar{K}$. In addition, there is a unit variable cost of $\bar{c}^i$ for production of product i, which can be sold externally at price $\bar{p}^i$.

Each product is produced by a worker whose output is given by $x^i=X^i(a^i,\theta^i)$, $i=A,B$, where i denotes the agent, a^i the effort level and θ^i the productivity of the central resource in producing agent i's output. The productivity in the division manned by agent i is either high (θ^i_2) or low (θ^i_1) and is known perfectly by agent i alone (due to expertise and firsthand knowledge) before the contract is accepted from the owner. The resource productivities, and thus the agents' private information, are correlated in the following sense:

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[2] Among those who have used the correlated information model, only Ma et al. (1988) recognize that the introduction of communication may alter the nature of the optimal contracts. They do not analyze that scenario, however, speculating that the owner might not be able to precommit to such schemes in practice.

$$\text{For } i,j=A,B, i\neq j,$$

$$1>q^i_1=\text{Prob}\{\text{Agent } j \text{ is } \theta_1 \mid \text{Agent } i \text{ is } \theta_1\}$$
$$>\text{Prob}\{\text{Agent } j \text{ is } \theta_1 \mid \text{Agent } i \text{ is } \theta_2\}=q^i_2>0.$$

That is, the resource is more likely to be of a certain productivity in one division when it is of that same productivity in the other division as well. This relationship exists since the same central resource is utilized by both divisions. However, the correlation is imperfect since the divisions use the resource for different purposes. Denote the unconditional probability that the resource has low productivity in division i by p^i_1 and let $p^i_2=1-p^i_1$.

The production process for each agent yields concave returns to effort, that is, $X^i_a>0$ and $X^i_{aa}<0$. Also, for a given level of effort, the output level is higher in the high productivity state, $X^i(a^i,\theta^i_1)<X^i(a^i,\theta^i_2)\ \forall a^i$. The workers are economic agents whose utility functions are of the form $U^i(R,a)=U^i(R)-V^i(a)$, where R is compensation received and a the effort exerted. The workers are risk-averse $(U^i_R>0, U^i_{RR}<0)$, work averse $(V^i_a>0)$, and derive convex disutility from effort $(V^i_{aa}>0)$. Rewriting their disutility functions in terms of the output level and the state of productivity, let $D^i(x^i_s,\theta^i_t)$ be the disutility incurred by agent i in producing output x^i_s when his or her private information is θ^i_t. Therefore, $D^i_x>0, D^i_{xx}>0$, and $D^i(x^i,\theta^i_1)>D^i(x^i,\theta^i_2)\ \forall x^i$. In addition, I assume that the marginal disutility of effort is also greater in the low state $[D^i_x(x^i,\theta^i_1)>D^i_x(x^i,\theta^i_2)\ \forall x^i]$ and that it increases at a more rapid rate in the low state $[D^i_{xx}(x^i,\theta^i_1)>D^i_{xx}(x^i,\theta^i_2)\ \forall x^i]$. These assumptions, similar to those commonly employed in economics, help characterize the optimal incentive schemes. The last, in particular, is crucial; it is a sufficient condition for the validity of using first-order conditions to derive the optimal incentive schemes. It is also used to show that implementation problems exist in settings with communication.

The entrepreneur is assumed to be a risk-neutral, expected-profit maximizer whose problem is that the agents' information about the productivity of the central resource in their own divisions is private and their effort levels are unobservable. But if the owner can precommit to incentive schemes and receive information from the agents, then, from the Revelation Principle, it is optimal for the owner to induce the agents to report their private information truthfully; in return, the owner precommits to a required output and a corresponding payment for each agent, on the basis of the information received from *both* agents.

Denote by x^i_{st} the output that agent i is asked to produce when he or she reports θ^i_s and agent j submits θ^j_t; similarly, denote agent i's compensation upon producing that output as R^i_{st}. Assume that for each report θ^i_s, agent i must expect to receive a reservation utility of at least $\bar{U}^i$ in order to stay with the firm. However, once the information is reported, the agent is effectively committed to working for the firm. The optimal incentive scheme is then given by:[3]

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[3] The size of the resource is now fixed and so plays no role in the contracting process. It is possible to make the resource level a choice variable by specifying a cost function for it, as well as a description of how it affects the production process. For each level of the resource, and in particular the optimal resource size, the problem under study would still arise.

$$\begin{array}{ll}\underset{\{R^i_{st},x^i_{st}\}}{\text{Max}} & p^A_1q^A_1[(\bar{p}^A-\bar{c}^A)x^A_{11}-R^A_{11}+(\bar{p}^B-\bar{c}^B)x^B_{11}-R^B_{11}]+ \\ & p^A_1(1-q^A_1)[(\bar{p}^A-\bar{c}^A)x^A_{12}-R^A_{12}+(\bar{p}^B-\bar{c}^B)x^B_{21}-R^B_{21}]+ \\ & p^A_2q^A_2[(\bar{p}^A-\bar{c}^A)x^A_{21}-R^A_{21}+(\bar{p}^B-\bar{c}^B)x^B_{12}-R^B_{12}]+ \\ & p^A_2(1-q^A_2)[(\bar{p}^A-\bar{c}^A)x^A_{22}-R^A_{22}+(\bar{p}^B-\bar{c}^B)x^B_{22}-R^B_{22}],\end{array}$$

subject to:

1. $q^i_1[U^i(R^i_{11})-D^i(x^i_{11},\theta^i_1)]+(1-q^i_1)[U^i(R^i_{12})-D^i(x^i_{12},\theta^i_1)]\geq\bar{U}^i, i=A,B$
2. $q^i_2[U^i(R^i_{21})-D^i(x^i_{21},\theta^i_2)]+(1-q^i_2)[U^i(R^i_{22})-D^i(x^i_{22},\theta^i_2)]\geq\bar{U}^i, i=A,B$
3. $q^i_1[U^i(R^i_{11})-D^i(x^i_{11},\theta^i_1)]+(1-q^i_1)[U^i(R^i_{12})-D^i(x^i_{12},\theta^i_1)]\geq$
   $q^i_1[U^i(R^i_{21})-D^i(x^i_{21},\theta^i_1)]+(1-q^i_1)[U^i(R^i_{22})-D^i(x^i_{22},\theta^i_1)] \qquad i=A,B$
4. $q^i_2[U^i(R^i_{21})-D^i(x^i_{21},\theta^i_2)]+(1-q^i_2)[U^i(R^i_{22})-D^i(x^i_{22},\theta^i_2)]\geq$
   $q^i_2[U^i(R^i_{11})-D^i(x^i_{11},\theta^i_2)]+(1-q^i_2)[U^i(R^i_{12})-D^i(x^i_{12},\theta^i_2)] \qquad i=A,B$

Proposition 1: With the assumption of interior solutions, the optimal incentive scheme for each agent is characterized by the following:

C1. $R_{11}>R_{12}$; $R_{21}=R_{22}=:R_2$;
C2. $x_{11}<x_{12}$; $x_{21}=x_{22}=:x_2$;
C3. $q_1[U(R_{11})-D(x_{11},\theta_1)]+(1-q_1)[U(R_{12})-D(x_{12},\theta_1)]=\bar{U}>U(R_2)-D(x_2,\theta_1)$; and
C4. $q_2[U(R_{11})-D(x_{11},\theta_2)]+(1-q_2)[U(R_{12})-D(x_{12},\theta_2)]=U(R_2)-D(x_2,\theta_2)\geq\bar{U}$.

By asking the agents to communicate their knowledge, the owner can offer each manager the choice of four outputs, corresponding to the four possible realizations of the private information vector within the firm (i.e., output x^i_{st} when the state vector is (θ^i_s,θ^j_t), $s,t=1,2$). In contrast, the schemes studied by Demski and Sappington (1984) and Ma et al. (1988) in effect delegate the choice of output to the divisions; each manager has the choice of just two outputs, corresponding to the dimensionality of his or her own private information (i.e., output x^i_s when the manager's state is $\theta^i_s, s=1,2$). Clearly, the owner is made weakly better off by allowing communication since the owner can replicate any solution to the delegation game by setting $x^i_{s1}=x^i_{s2}=:x^i_s, s=1,2$. In fact, the following stronger result can be derived.

Proposition 2: The expected profits from the communication game are strictly higher than those in the delegation game.

Melumad and Reichelstein (1987) show that when a single agent has perfect private information (i.e., can predict the result of his or her action with certainty), the owner is indifferent between asking the agent to communicate that information and delegating the choice of action to the agent. Proposition 2 demonstrates that this result does not extend to multiagent settings; in the model proposed here, despite the perfect private information held by either agent, the owner is strictly better off with a centralized, communication scheme rather than one involving delegation.[4]

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[4] This is especially surprising, as the correlation in the resouce productivities is strictly an informational one; i.e., the private information of one division imposes no externality on the production process of the other. It is thus not obvious *ex ante* that the output that each division is asked to produce should depend on the productivity of the other division.

In a single-agent setting, a communication scheme would effectively solve the incentive problem by inducing truthful reporting from the agent. With multiple agents, however, the owner cannot be assured of obtaining the second-best profit level. The optimal contracts in Proposition 1 induce honesty as a Bayesian equilibrium; that is, they provide incentives for each agent to report honestly, *provided* the other agent is honest. However, they leave open the possibility that both agents, by deviating simultaneously, can make themselves better off. In fact, such a beneficial deviation does exist with the communication scheme and, more importantly, can be sustained, as it is also a Bayesian equilibrium in the agents' subgame.

Proposition 3: It is a Pareto-dominant equilibrium for both agents to report θ_1^i always.

The agents could thus collude implicitly, without any communication or contracting between themselves, and obtain higher utilities by reportng θ_1^i always. Their choice of this equilibrium would, however, lead to a loss of profits for the owner, who would not receive the second-best return on an investment in the central resource. In a competitive setting, the owner would not even recover the fixed investment. The deliberate under-reporting by the agents leads to a non-optimal use of the resource, given its state of productivity. It is in the owner's interest then to ensure that the agents do report truthfully. The next section shows how this can be accomplished by allocating the cost of the central resource to the agents.

II. The Cost Allocation System and Proof of Its Effectiveness

Horngren and Foster (1987, 373–74) point out that management control systems exist primarily to improve collective decisions within an organization. The problem the owner faces in our setting is clearly one of collective decision making by the managers. Each manager is sufficiently motivated to behave in the firm's interest, but collectively the two managers find it better to make decisions that are against the owner's goals. To address this problem, a control system such as a cost allocation mechanism "attempts to achieve divisional behavior-congruence via direct or indirect manipulation of divisions' book profits" (Thomas 1977, 13). The owner thus ties the compensation of the division managers to their accounting divisional profits and manipulates them by allocating lower costs when division managers do what the owner wants and higher costs otherwise.

In the present private-information scenario, one could introduce a cost allocation scheme based on operational budgets that the divisions submit. It is easily ensured that each department will provide accurate budgets about the output it will produce. However, the owner would still not know whether these outputs correspond to the *desired* outputs, given the managers' private information. I show that an appropriate choice of overhead rates, based on rounds of budgeting by the departments, can exploit the correlation in the managers' private information and guarantee that they will submit budgets for the desired output levels. Each division's production is then made to conform to its budget by taking into account excessive differences in the two values.

The time line in figure 1 summarizes the operation of the scheme. Initially, each agent is asked either to submit an acceptable operational budget specifying the quantity of output to be produced or to leave the firm. The budget from division *i* is considered acceptable if it reflects an intent to produce in one of two non-overlapping

Figure 1

Time Line for the Operation of the Cost Allocation Mechanism

Information Stage	*Initial Reporting*	*Final Reporting*	*Allocation Stage*	*Production Stage*	*Reward Stage*
Managers acquire private information about the productivity of the central resource.	Each manager either submits an acceptable budget for output or refuses to work for the firm; in the latter case, the manager's involvement in the game is terminated.	If a manager's initial budget is acceptable but low, the owner asks for a new budget that must lie within a designated region.	Each manager receives a predetermined overhead rate based on the final budget, which determines the allocated cost.	Managers produce their outputs; if these differ excessively from the budgets, the managers are penalized for the deviation.	Managers are paid according to their accounting divisional profit (i.e., [Actual Output × Contribution Margin] less Allocated Costs).

ranges—$[x_1^i, x_1^i + v^i]$ or $[x_2^i, x_2^i + v^i]$. If the budget is in the higher range of $[x_2^i, x_2^i + v^i]$, the division need engage in no further reporting and simply has to produce an output quantity within the range. If, however, the budget falls into the artificially created lower range, the division is required to engage in a second round of budgeting. If the other division's initial budget was in $[x_1^j, x_1^j + v^j]$ or if that division manager refused to work for the firm, division *i* must resubmit a budget in the range $[x_{11}^i, x_{11}^i + v^i]$; however, if *j* submitted a high initial budget, division *i*'s new budget must lie in a different, higher range, namely $[x_{12}^i, x_{12}^i + v^i]$. Again, division *i*'s actual production in the next stage must lie within the range of its final budget.

Each division manager is committed to staying with the firm and budgeting and producing output quantities within the relevant ranges once the initial budget is accepted. The principal precommits to issuing specific overhead rates to each department on the basis of the initial and final budgets submitted by both managers; the rate is not necessarily the same for each department. The budgets are costless to send, and it is assumed that agents can confirm that the reports they sent were received by the principal.[5]

The principal operationalizes the scheme by treating the agents as profit centers. Each agent is compensated by using a linear function of the performance evaluation measure, which is the divisional accounting profit after allocation of overhead. The amount of overhead allocated to each division is a lump sum determined by the product of the appropriate absorption rate and the final output budgeted. Suppose the division manager submits a final budget of x and receives rate k. If output quantity $\hat{x}$, which is within the relevant range, is then produced, the manager is evaluated according to the statistic $[\hat{x}(\bar{p}-\bar{c})-kx]$ and is paid $\alpha_{st}+\beta_{st}[\hat{x}(\bar{p}-\bar{c})-kx]$. The parameters of this incentive plan, α_{st} and β_{st}, depend on the particular output ranges of the initial budgets.[6] The βs, which denote the fraction of the divisional accounting profit that is paid as bonus to the agents, are chosen to be positive and less than unity (also see conds. [F1]–[F4] in appendix A). The αs, which denote the fixed component of the agents' compensation, are then chosen to ensure that the compensation paid to the managers in equilibrium is optimal, as determined by the second-best contracts (see conds. [G1]–[G4] in appendix A).

Each manager's compensation thus takes the commonly observed form of a salary plus a bonus based on a performance evaluation measure (i.e., divisional accounting profit). The compensation scheme, however, is in effect only if the divisional output is in the range stated in the final budget; otherwise, the division is penalized. The existence of this implicit penalty ensures that extreme deviations at the production stage are never optimal for the divisions.[7] Given the agents' aversion to effort, the

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[5] The ability of the principal to precommit to incentive schemes and that of the agents to precommit to stay with the firm, as well as the costless sending of messages from the agents to the owner, are assumptions implicit in the way the Revelation Principle was used to derive the optimal contracts. The present assumptions thus impose no further structure on the problem.

[6] Suppose $\bar{c}$ represents the variable cost of using the central resource. The designed scheme is then a dual-rate allocation system with variable costs absorbed on predetermined rates using actual output (the rate being a constant $\bar{c}$) and fixed costs allocated as a lump-sum based on budgeted volume. This is the exact scheme that Fremgen and Liao (1981, 75) propose as the ideal mechanism when cost allocation is used for performance evaluation purposes.

[7] One such penalty used in practice (see Horngren and Foster 1987, 421) is that divisions are charged higher overhead rates *ex post* if their output differs excessively from that budgeted. But, from a technical standpoint, note that the managers could have been restricted to produce outputs in the same range as their final budgets, just as their budgets were restricted to lie within certain ranges. Clearly, there are implicit penalties that ensure that agents stay within allowed message spaces, and these can be made explicit through the use of such rates.

Table 1

Panel A. Agent i's Fixed Cost Allocation Rate:

Agent i's Initial Budget	*Agent j's Initial Reporting Choice* $[x^j_1, x^j_1 + v^j]$	$[x^j_2, x^j_2 + v^j]$	*Refuse*
x_1	*Resubmit* $x \in [x_{11}, x_{11} + v]$ $\frac{\bar{K}}{x^j_{11} + x}$	*Resubmit* $x \in [x_{12}, x_{12} + v]$ $\frac{\bar{K}}{x^j_2 + x}$	*Resubmit* $x \in [x_{11}, x_{11} + v]$ $\frac{\bar{K}}{x^j_{11} + x}$
$x_1 + \epsilon$ $0 < \epsilon \leq v$	*Resubmit* $x \in [x_{11}, x_{11} + v]$ $\frac{\bar{K} - b + \epsilon}{x^j_{11} + x}$	*Resubmit* $x \in [x_{12}, x_{12} + v]$ $\frac{\bar{K} + d + \epsilon}{x^j_2 + x}$	*Resubmit* $x \in [x_{11}, x_{11} + v]$ $\frac{\bar{K} - b + \epsilon}{x^j_{11} + x}$
$x \in [x_2, x_2 + v]$	$\frac{\bar{K}}{x^j_{12} + x}$	$\frac{\bar{K}}{x^j_2 + x}$	$\frac{\bar{K} + d}{x^j_{12} + x}$
Refuse	—	—	—

Panel B. Agent i's Compensation Function:

Agent i's Initial Budget	*Agent j's Initial Reporting Choice* $[x^j_1, x^j_1 + v^j]$	$[x^j_2, x^j_2 + v^j]$	*Refuse*
$[x_1, x_1 + v]$	$\alpha_{11} + \beta_{11}(\cdot)$	$\alpha_{12} + \beta_{12}(\cdot)$	$\alpha_{11} + \beta_{11}(\cdot)$
$[x_2, x_2 + v]$	$\alpha_{21} + \beta_{21}(\cdot)$	$\alpha_{22} + \beta_{22}(\cdot)$	$\alpha_{21} + \beta_{21}(\cdot)$

owner can thus ensure the choice of the correct output level for each realization of the private information vector by eliciting a "truthful" budget of x^i_1 in state θ^i_1 and x^i_2 in state θ^i_2 from agent i.

The fixed overhead rates that will be charged against each agent's divisional contribution in the various contingencies, as well as the agents' compensation schemes, are detailed in table 1. As the construction is symmetrical, it is sufficient to focus on one of the agents. Also, because the payments generated by the mechanism are clustered around the second-best payoffs, and the range of payments can be controlled by varying the mechanism's parameters, issues regarding whether the final compensations to the agents are outside the feasible range of payoffs can be ignored.

Now, the positive quantities "b" and "d," which affect the total overhead that is allocated in certain situations, are chosen to satisfy conditions (H1) through (H3) (in appendix A); similarly, v, the measure of the budgeting and production ranges, satisfies conditions (J1) through (J4). Conditions (H3) and (J2) are key inequalities in the construction of the mechanism. Condition (H3) ensures that agents in the low and high states prefer to budget x_1 and x_2, respectively, over any budget in (x_1, x_1+v) when the other agent is truthful. It thus aids in sustaining truthful budgeting as equilibrium behavior. Condition (J2), conversely, implies that when agent *j* never budgets in the range (x_2, x_2+v), agent *i* will prefer to submit an initial budget of x_1+v rather than x_1. This ensures that *i* will deviate from the strategy of budgeting x_1 always, thus removing the equilibrium the owner wishes to prevent. Another important feature of the allocation scheme is the distinctly different rate schedule that agents face for budgeting x_1 rather than outputs in (x_1, x_1+v) (see fig. 2). That is, x_1, which is the budget level that the agents wish to coordinate on, is treated as a "critical point" in the design of the overhead rates. This aids in preventing the creation of new equilibria with the introduction of the mechanism.

Note that once the reporting stage ends and agents are issued their overhead rates, each agent is no longer concerned about the actual output choice of the other and in effect controls his or her own compensation. Thus, any interaction between the agents can be summarized in terms of the initial budgets alone, keeping in mind the subsequent best final budgeting and production choices for each. The following equilibrium notion is therefore appropriate to study the strategies that the two managers will follow, given this mechanism:

> A perfect Bayesian equilibrium is a set of initial and (if needed) final budgeting strategies, and a subsequent production strategy for each type of agent, such that: (1) the initial budgeting strategies form a Bayesian equilibrium, taking into account the optimal final budgeting and production strategies that would follow, and (2) the production strategies are sequentially rational, given the prior budgeting choices.

Before stating the main result, it is convenient to first identify the final budgeting and production strategies that agents would follow in the event that certain initial budget pairs are submitted to the owner.

Lemma 1: If agent *i* initially budgets x_1, he or she will submit a final budget for (and subsequently produce) either x_{11} or x_{12}, depending on the range for the resubmission.

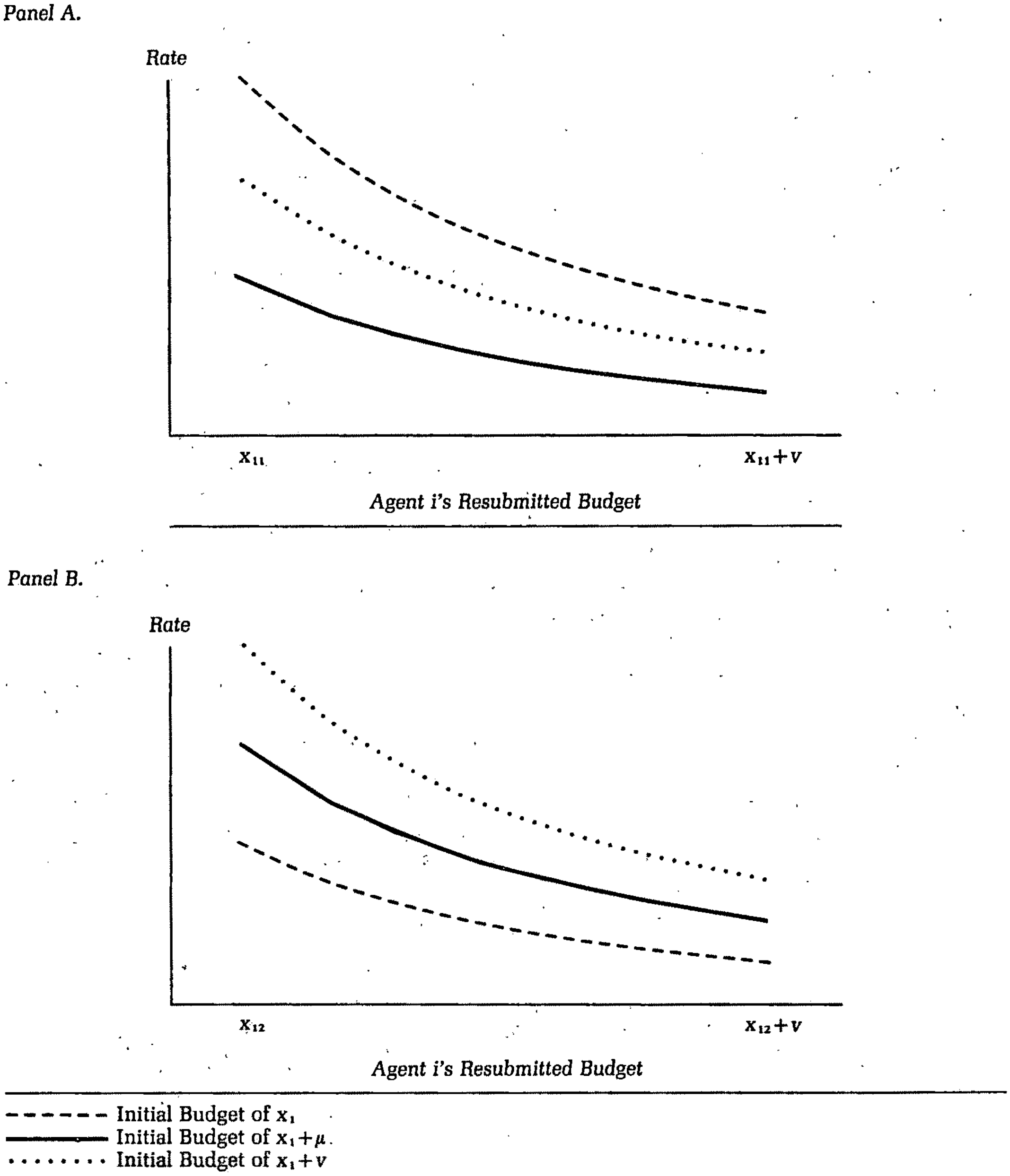
Lemma 2: If agents with processes in state θ_2 budget x_2, they subsequently produce x_2.

If the owner could induce truthful budgeting, Lemmas 1 and 2 then indicate that the production of the managers would be the optimal output levels, for any of the possible state realizations in the firm. From the design of the agents' compensation functions, the payments to the managers would also be the optimal second-best payoffs. The following result establishes that the allocation scheme does indeed elicit truthful budgets.

Proposition 4: There is a unique perfect Bayesian equilibrium in the game played by the agents, which involves agent *i*'s initially budgeting x_1^i with private information θ_1^i and budgeting (and producing) x_2^i with information θ_2^i, $i=A,B$. Further, if *i*'s initial budget of x_1^i is met by *j*'s x_1^j, agent *i* subsequently budgets and produces x_{11}^i; if, however, *j* submits x_2^j when *i* budgets x_1^i, agent *i* subsequently budgets and produces x_{12}^i.

The cost allocation scheme is successful in motivating the agents to produce honestly because the budgeting stages help capture the interplay between them, through

Figure 2
Overhead Rate Schedules for Agent *i* for Resubmitted Budgets



the joint determination of overhead rates. Each division manager is interested in minimizing his or her share of the overhead and therefore chooses a budgeted output quantity in response to beliefs about the other division's budget, in order to benefit from the changing overhead rates. However, because of the rounds of budgeting and the variance allowed between the budgeted and actual production, the manager is not then forced to produce that exact quantity. There is thus no cost to budgeting the output quantity that minimizes the expected overhead burden. By offering this inducement to divisions, the owner can treat each one's budget as implicitly providing information about the other. Then, by appropriately allocating costs on the basis of this information, the owner dissuades the managers from colluding with each other.

The non-obedient equilibrium of the revelation game has been removed since each agent prefers to budget some output higher than x_1 in response to the other agent's always choosing x_1. The desired equilibrium is left undisturbed since agents still prefer to budget and produce honestly in response to the other agent's truthfulness. By introducing a discontinuity in the selection of the overhead rate schedules (illustrated in fig. 3), the truthful equilibrium is ensured to be the unique one in the game. Further, the rates are designed so that the agents receive their optimal (second-best) payoffs in this equilibrium.

III. Properties of the Allocation Scheme

The relevance of various concepts in the accounting literature to this cost allocation scheme is dealt with in this section. First, note that the allocation of indirect costs represents part of an efficient control system since it costlessly guarantees the owner's expected profits. In addition, allocations occur in equilibrium to reduce the agents' compensation (through the performance evaluation measure) to the optimal levels. Equilibrium allocations are thus neutral or sterile from the viewpoint of affecting agents' decisions and are a simple, costless way of reminding workers of the existence of indirect costs. Allocations in other contingencies then ensure that agents stay on the equilibrium path and contribute to the recovery of those costs. Thus, with a mechanism-design approach, neutrality emerges in equilibrium, and yet allocation plays a vital economic role.[8]

Now, within the particular cost allocation system described in section II, consider the structure of the overhead rates. The overhead rate for each agent decreases with output in each final budgeting range and yet, to minimize the overhead burden, agents prefer to budget the lowest output forecast in each range. Another contradictory feature is that, although the overhead rate structure is symmetric for the agents, they are not allocated the same rates in every situation or charged the same amount of fixed costs. Given the emphasis on "equity" in the cooperative game literature on allocations, the following result is of interest.

> *Proposition 5:* Assume that the agents have identical preferences and reservation utilities and produce products with the same contribution margin. Then, if $q_s^A = q_s^B$, $s = 1,2$, and $p_1^A(1-q_1^A) = p_2^A q_2^A$, the divisions will, with positive probability (less than 1), be allocated identical overhead rates and will absorb equal amounts of indirect costs in equilibrium.

Thus, even with the symmetry imposed above, the agents may absorb differing amounts of overheads. This is because when one division budgets x_1 and the other x_2, their managers must be treated asymmetrically; the first is penalized by being asked to

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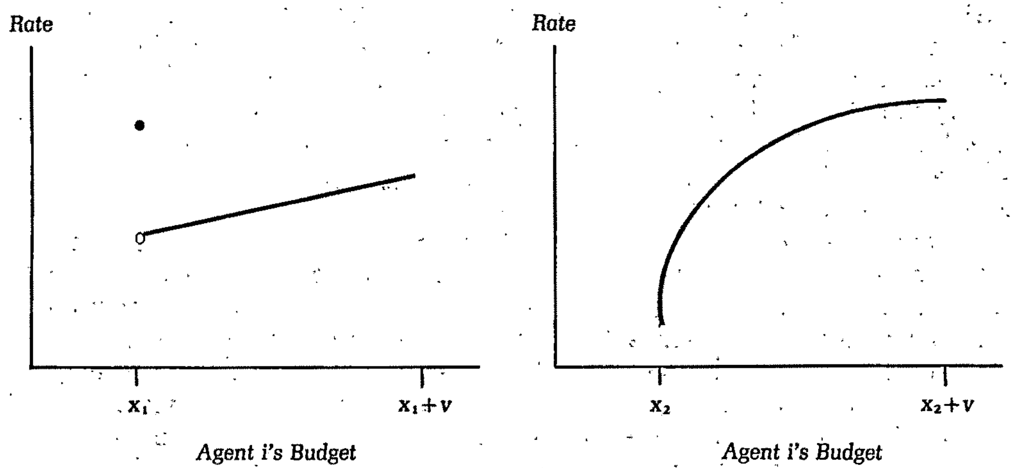
[8] By contrast, earlier research using operations research and cooperative game theory perspectives viewed the major role of cost allocations as *being neutral*; examples include Kaplan and Welam (1974) and Hamlen et al. (1977).

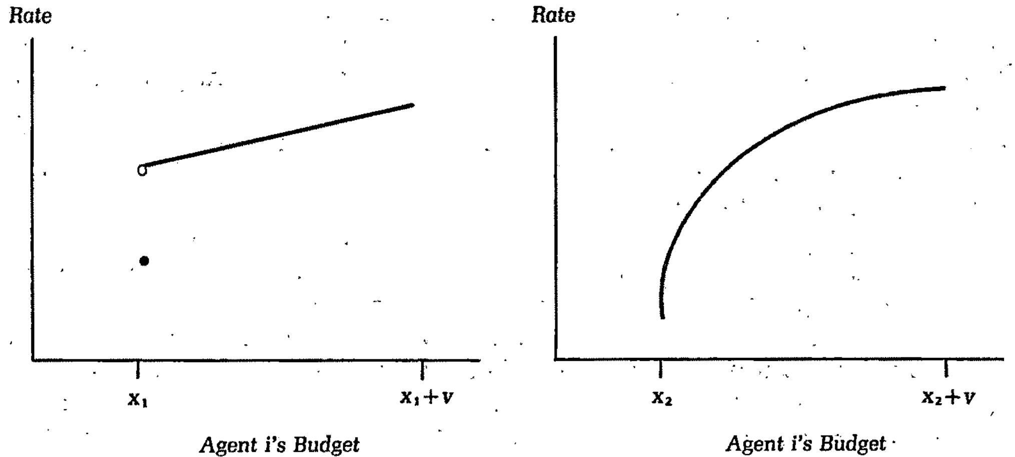
Figure 3

Overhead Allocated to Agent *i* as a Function of the Initial Budgets, Assuming Optimal Second-Round Budgeting and Production

Panel A. Agent j Budgets in $[x_1^j, x_1^j+v^j]$:



Panel B. Agent j Budgets in $[x_2^j, x_2^j+v^j]$



produce a higher output (and also by being paid less) than if the other division had also budgeted x_1. Therefore, equitable allocations can arise, but the seemingly arbitrary allocations that owners make may have specific purposes too and may not be replaceable by flat fees.

An allocation is said to be "full" or "tidy" (Demski 1981) when 100 percent of the indirect costs are divided between the producing divisions. Since the level of costs that is allocated is an important part of the mechanism, the following result identifying the relationship of the final allocations to the initial indirect cost is of interest.

Proposition 6: The cost allocation system is *ex post* tidy. That is, in each state realization, the total cost allocated to the producing divisions equals the total amount of indirect costs.

As the allocation system is tidy *ex post*, it is clearly tidy *ex ante* (i.e., in expectation over the possible state realizations). However, this result holds true only because the total amount of indirect costs is fixed and known beforehand. Suppose we vary the model to allow for a stochastic indirect cost, with some density $f(k)$ on its possible realizations. Then, assuming that this density is independent of actions taken by the producing departments, let $\bar{K}=E(k)$, the expected cost, and design the overheads as before. The allocation system is then tidy *ex ante* (because expected cost allocation $=\bar{K}=$expected indirect cost). However, it is not tidy *ex post*, since the actual indirect cost would, with probability 1, not equal $\bar{K}$.[9]

In the context of performance evaluation, the only variable of interest to owners and managers is the total amount of fixed costs allocated in any given situation. The mechanism in section II can thus be altered to conform to various empirically observed allocation systems. For instance, the amount of overhead allocated to each division in equilibrium is now based on its share of the total ouput of the firm. The scheme can be modified so that the allocation base is instead the relative contribution generated by each division toward firm profits. The overhead rate schedule can also be varied, as can the nature of the variance allowed between the budgets and actual production.

IV. Concluding Comments

This article presents a positive role for indirect cost allocations in motivating managers to behave in a desired manner that cannot be enforced through simple contracts. Of course, cost allocation is not the unique mechanism through which such implementation can be effected. Rather, its presence in organizations is shown to be consistent with its performing such a role; that is, some allocation schemes appear to be implementation mechanisms. This economic function is in line with explanations by practitioners and accounting textbooks.

The cost allocation mechanism presented in this article implements the desired equilibrium uniquely, given the assumed organizational structure. With more complex informational structures or a greater number of divisions, the number of unwanted equilibria that would arise with second-best contracts would be much higher, making implementation more difficult to achieve. Similarly, in the presence of a self-interested service department rather than a fixed, common cost, the analyis would be more complicated because of the resulting three-person subgame. However, if a behavioral assumption restricted the agents to pure strategies alone, implementation might still be feasible in all these settings.[10]

The economic role for indirect cost allocations can be attributed to other accounting systems as well. Rajan (1991) shows that the introduction of accounting reports and control systems may be useful in eliminating coordination problems in certain sequential organizations. These results support the view of Thomas (1977, 13), who notes that accounting practices such as transfer pricing and cost allocation attempt the "control of subordinates via pseudo income statements." The basic ideas presented here thus apply to a wide range of issues and provide a logical progression from the study of simple contracts to the study of accounting systems that resolve motivational issues when such contracts fail.

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[9] Such schemes do exist—Fremgen and Liao (1981, 44) note that when predetermined costs are allocated, variances from actual costs are not allocated in most cases (31 of 40, or 77.5 percent).

[10] For instance, in the present model, implementation in pure strategies can be achieved by a simple, finite game, rather than the continuous message spaces that have been used.

Appendix A

Choice of Parameters in Constructing the Cost-Allocation System

(F1): $\beta_{11}U'(R_{11})(\bar{p}-\bar{c})<D_x(x_{11},\theta_2)$

(F2): $\beta_{12}U'(R^*_{12})(\bar{p}-\bar{c})<D_x(x_{12},\theta_2)$, for some $R^*_{12}<R_{12}$

(F3): $\beta_{21}U'(R^*_2)(\bar{p}-\bar{c})<D_x(x_2,\theta_2)$, for some $R^*_2<R_2$

(F4): $\beta_{22}U'(R_2)(\bar{p}-\bar{c})<D_x(x_2,\theta_2)$

(G1): $$\alpha_{11}+\beta_{11}\left[x_{11}(\bar{p}-\bar{c})-\bar{K}\left(\frac{x_{11}}{x'_{11}+x_{11}}\right)\right]=R_{11}$$

(G2): $$\alpha_{12}+\beta_{12}\left[x_{12}(\bar{p}-\bar{c})-\bar{K}\left(\frac{x_{12}}{x'_{2}+x_{12}}\right)\right]=R_{12}$$

(G3): $$\alpha_{21}+\beta_{21}\left[x_{2}(\bar{p}-\bar{c})-\bar{K}\left(\frac{x_{2}}{x'_{12}+x_{2}}\right)\right]=R_{2}$$

(G4): $$\alpha_{22}+\beta_{22}\left[x_{2}(\bar{p}-\bar{c})-\bar{K}\left(\frac{x_{2}}{x'_{2}+x_{2}}\right)\right]=R_{2}$$

(H1): $$\alpha_{12}+\beta_{12}\left[x_{12}(\bar{p}-\bar{c})-(\bar{K}+d)\left(\frac{x_{12}}{x'_{2}+x_{12}}\right)\right]>R^*_{12}$$

(H2): $$\alpha_{21}+\beta_{21}\left[x_{2}(\bar{p}-\bar{c})-(\bar{K}+d)\left(\frac{x_{2}}{x'_{12}+x_{2}}\right)\right]>R^*_{2}$$

(H3): $$q_1U\left\{\alpha_{11}+\beta_{11}\left[x_{11}(\bar{p}-\bar{c})-(\bar{K}-b)\left(\frac{x_{11}}{x'_{11}+x_{11}}\right)\right]\right\}$$
$$+(1-q_1)U\left\{\alpha_{12}+\beta_{12}\left[x_{12}(\bar{p}-\bar{c})-(\bar{K}+d)\left(\frac{x_{12}}{x'_{2}+x_{12}}\right)\right]\right\}$$
$$<q_1U(R_{11})+(1-q_1)U(R_{12})$$

(J1): $v<\mathrm{Min}\{x_2-x_1,x_{12}-x_{11}\}$

(J2): $v<b$

(J3): $$U\left\{\alpha_{21}+\beta_{21}\left[(x_2+v)(\bar{p}-\bar{c})-\bar{K}\left(\frac{x_{2}}{x'_{12}+x_{2}}\right)\right]\right\}-D(x_2,\theta_1)<\bar{U}$$

(J4): $$U\left\{\alpha_{22}+\beta_{22}\left[(x_2+v)(\bar{p}-\bar{c})-\bar{K}\left(\frac{x_{2}}{x'_{2}+x_{2}}\right)\right]\right\}-D(x_2,\theta_1)<\bar{U}$$

Appendix B
Proofs for Propositions 1 through 6

Proof of Proposition 1

Consider the optimization problem for each agent and let $\lambda_1-\lambda_4$ represent the Lagrange multipliers on the four constraints. For an interior solution to the problem, the following eight first-order conditions must each be set equal to zero:

$$x_{11}\colon\ p_1q_1(\bar{p}-\bar{c})-\lambda_1q_1D_x(x_{11},\theta_1)-\lambda_3q_1D_x(x_{11},\theta_1)+\lambda_4q_2D_x(x_{11},\theta_2) \tag{L1}$$
$$x_{12}\colon\ p_1(1-q_1)(\bar{p}-\bar{c})-\lambda_1(1-q_1)D_x(x_{12},\theta_1)-\lambda_3(1-q_1)D_x(x_{12},\theta_1)+\lambda_4(1-q_2)D_x(x_{12},\theta_2) \tag{L2}$$
$$x_{21}\colon\ p_2q_2(\bar{p}-\bar{c})-\lambda_2q_2D_x(x_{21},\theta_2)+\lambda_3q_1D_x(x_{21},\theta_1)-\lambda_4q_2D_x(x_{21},\theta_2) \tag{L3}$$
$$x_{22}\colon\ p_2(1-q_2)(\bar{p}-\bar{c})-\lambda_2(1-q_2)D_x(x_{22},\theta_2)+\lambda_3(1-q_1)D_x(x_{22},\theta_1)-\lambda_4(1-q_2)D_x(x_{22},\theta_2) \tag{L4}$$
$$R_{11}\colon\ -p_1q_1+\lambda_1q_1U'(R_{11})+\lambda_3q_1U'(R_{11})-\lambda_4q_2U'(R_{11}) \tag{L5}$$
$$R_{12}\colon\ -p_1(1-q_1)+\lambda_1(1-q_1)U'(R_{12})+\lambda_3(1-q_1)U'(R_{12})-\lambda_4(1-q_2)U'(R_{12}) \tag{L6}$$
$$R_{21}\colon\ -p_2q_2+\lambda_2q_2U'(R_{21})-\lambda_3q_1U'(R_{21})+\lambda_4q_2U'(R_{21}) \tag{L7}$$
$$R_{22}\colon\ -p_2(1-q_2)+\lambda_2(1-q_2)U'(R_{22})-\lambda_3(1-q_1)U'(R_{22})+\lambda_4(1-q_2)U'(R_{22}) \tag{L8}$$

Assume for now that the third constraint—the incentive compatibility (IC) constraint for the low state—does not bind (i.e., $\lambda_3=0$); this is later shown to be true. The IC constraint for the high state must then bind (i.e., $\lambda_4>0$), since otherwise we would be in a first-best setting. Also, from condition (L5), $U'(\bullet)>0$ and $p_1q_1>0$ implies that $\lambda_1>0$ (i.e., the first constraint is binding).

To show that $x_{21}=x_{22}$ *and* $R_{21}=R_{22}$: Dividing condition (L3) through by $q_2(\lambda_2+\lambda_4)$ and condition (L4) by $(1-q_2)(\lambda_2+\lambda_4)$ yields:

$$D_x(x_{21},\theta_2)=\frac{p_2(\bar{p}-\bar{c})}{\lambda_2+\lambda_4}=D_x(x_{22},\theta_2)\Rightarrow x_{21}=x_{22}=x_2,$$

say. Similarly, dividing condition (L7) by $q_2(\lambda_2+\lambda_4)$ and condition (L8) by $(1-q_2)(\lambda_2+\lambda_4)$ yields the equality:

$$U'(R_{21})=\frac{p_2}{\lambda_2+\lambda_4}=U'(R_{22}),$$

which implies that $R_{21}=R_{22}=R_2$, say.

To show that $R_{11}>R_{12}$: From condition (L6):

$$\lambda_1(1-q_1)-\lambda_4(1-q_2)>0\Rightarrow\frac{\lambda_1}{\lambda_4}>\frac{1-q_2}{1-q_1}>1\Rightarrow\lambda_1>\lambda_4.$$

Then, from conditions (L5) and (L6), using the fact that $\lambda_1>\lambda_4$ and $q_2<q_1$,

$$\frac{U'(R_{11})}{U'(R_{12})}=\left(\frac{p_1}{\lambda_1-\lambda_4\dfrac{q_2}{q_1}}\right)\left(\frac{\lambda_1-\lambda_4\dfrac{(1-q_2)}{(1-q_1)}}{p_1}\right)<1\Rightarrow U'(R_{11})<U'(R_{12})\Rightarrow R_{11}>R_{12}.$$

To show that $x_{11}\neq x_{12}$: Dividing condition (L1) by q_1 and condition (L2) by $(1-q_1)$ yields the following equality:

$$\lambda_1D_x(x_{11},\theta_1)-\lambda_4\frac{q_2}{q_1}D_x(x_{11},\theta_2)=\lambda_1D_x(x_{12},\theta_1)-\lambda_4\frac{1-q_2}{1-q_1}D_x(x_{12},\theta_2). \tag{L9}$$

Now, suppose $x_{11}=x_{12}=x_1$, say. Condition (L9) would then simplify to:

$$\lambda_4\frac{q_2}{q_1}D_x(x_1,\theta_2)=\lambda_4\frac{1-q_2}{1-q_1}D_x(x_1,\theta_2)\Rightarrow\frac{q_2}{q_1}=\frac{1-q_2}{1-q_1},$$

which is impossible since $q_2<q_1$. Therefore, $x_{11}\neq x_{12}$.

To show that $x_{11}<x_{12}$: Suppose conversely that $x_{11}>x_{12}$. Rewrite condition (L9) as follows:

$$\lambda_1[D_x(x_{11},\theta_1)-D_x(x_{12},\theta_1)]=\lambda_4\left[\frac{q_2}{q_1}D_x(x_{11},\theta_2)-\frac{1-q_2}{1-q_1}D_x(x_{12},\theta_2)\right]$$

$$\Rightarrow \frac{\lambda_1}{\lambda_4} = \frac{\frac{q_2}{q_1} D_x(x_{11},\theta_2) - \frac{1-q_2}{1-q_1} D_x(x_{12},\theta_2)}{D_x(x_{11},\theta_1) - D_x(x_{12},\theta_1)}$$

The left-hand side of this expression exceeds 1. Since $x_{11} > x_{12}$, the denominator of the right-hand side is positive. Therefore, the numerator must also be positive and exceed the denominator in magnitude, i.e.,

$$\frac{q_2}{q_1} D_x(x_{11},\theta_2) - \frac{1-q_2}{1-q_1} D_x(x_{12},\theta_2) > D_x(x_{11},\theta_1) - D_x(x_{12},\theta_1)$$

$$\Rightarrow D_x(x_{11},\theta_2) - D_x(x_{12},\theta_2) > D_x(x_{11},\theta_1) - D_x(x_{12},\theta_1) \text{ [since } q_2 < q_1]$$

$$\Rightarrow D_x(x_{11},\theta_1) - D_x(x_{11},\theta_2) < D_x(x_{12},\theta_1) - D_x(x_{12},\theta_2).$$

However, because $D_{xx}(x,\theta_1) > D_{xx}(x,\theta_2)\ \forall x$,

$$x_{11} > x_{12} \Rightarrow D_x(x_{11},\theta_1) - D_x(x_{11},\theta_2) > D_x(x_{12},\theta_1) - D_x(x_{12},\theta_2),$$

which contradicts the above inequality. Therefore, $x_{11} < x_{12}$.

With $x_{11} < x_{12}$ and $R_{11} > R_{12}$, the proof strategy in steps 3 and 4 of Proposition 1 in Ma et al. (1988) can be adapted to first show that $x_2(\bar{p} - \bar{c}) - R_2 > q_1[x_{11}(\bar{p} - \bar{c}) - R_{11}] + (1 - q_1)[x_{12}(\bar{p} - \bar{c}) - R_{12}]$ and then to verify that the third constraint indeed does not bind. Finally, analysis of the second-order conditions reveals that the Hessian matrix of the Lagrangian is negative definite, that is, the identified solution is a strict relative maximum point.

Proof of Proposition 2

It is sufficient to show that *no* interior solution to the optimization problem above is characterized by $x_{11} = x_{12} = x_1$, say, *and* $x_{21} = x_{22} = x_2$, say. But suppose such a solution does exist. Conditions (L1) and (L2) can then be manipulated to yield:

$$D_x(x_1,\theta_1)(\lambda_1 + \lambda_3) - \lambda_4 \frac{q_2}{q_1} D_x(x_1,\theta_2) = D_x(x_1,\theta_1)(\lambda_1 + \lambda_3) - \lambda_4 \frac{1-q_2}{1-q_1} D_x(x_1,\theta_2),$$

$$\Rightarrow \lambda_4 \frac{q_2}{q_1} D_x(x_1,\theta_2) = \lambda_4 \frac{1-q_2}{1-q_1} D_x(x_1,\theta_2),$$

which cannot hold unless $\lambda_4 = 0$. Analogously, conditions (L3) and (L4) can be manipulated to get the equality:

$$\lambda_3 \frac{q_1}{q_2} D_x(x_2,\theta_1) = \lambda_3 \frac{1-q_1}{1-q_2} D_x(x_2,\theta_1),$$

which cannot hold unless $\lambda_3 = 0$. But $\lambda_3 = \lambda_4 = 0 \Rightarrow \lambda_1, \lambda_2 > 0$ (i.e., the participation constraints bind); further, $R_{11} = R_{12} = R_1$, say, and $R_{21} = R_{22} = R_2$, say. But then, $U(R_1) - D(x_1,\theta_2) > U(R_1) - D(x_1,\theta_1) = \bar{U} = U(R_2) - D(x_2,\theta_2)$ leads to a violation of the fourth constraint, thus completing the proof.

Proof of Proposition 3

This follows since $R_{11} > R_{12}$ and $x_{11} < x_{12}$ together imply that $U(R_{11}) - D(x_{11},\theta_1) > U(R_2) - D(x_2,\theta_1)$ (from cond. [C3]) and $U(R_{11}) - D(x_{11},\theta_2) > U(R_2) - D(x_2,\theta_2)$ (from cond. [C4]). Further, from conditions (C3) and (C4), both agents are better off than if they were honest.

Proof of Lemma 1

Suppose the agent budgets x_1 initially and must now resubmit in $[x_{11}, x_{11} + v]$ (an analogous proof holds if the agent were asked to resubmit in $[x_{12}, x_{12} + v]$ instead). The agent has to budget $\hat{x} \in [x_{11}, x_{11} + v]$ and, to avoid being penalized, produce $\hat{x} \in [x_{11}, x_{11} + v]$ to maximize:

$$U\left\{\alpha_{11} + \beta_{11}\left[\hat{x}(\bar{p} - \bar{c}) - x\left(\frac{\bar{K}}{x'_{11} + x}\right)\right]\right\} - D(\hat{x},\theta).$$

The agent must choose x to minimize the overhead allocation and clearly will budget x_{11}. The allocation is therefore:

$$\bar{K}\left(\frac{x_{11}}{x'_{11} + x_{11}}\right) = N,$$

say. At the production stage, the agent then produces $\hat{x} \in [x_{11}, x_{11} + v]$ to maximize: $h(\hat{x}) := U\{\alpha_{11}$

$+\beta_{11}[\hat{x}(\bar{p}-\bar{c})-N]\}-D(\hat{x},\theta)$. Now,

$$\begin{aligned} h'(x_{11}) &= U'\{\alpha_{11}+\beta_{11}[x_{11}(\bar{p}-\bar{c})-N]\}\beta_{11}(\bar{p}-\bar{c})-D_x(x_{11},\theta), \\ &= U'(R_{11})\beta_{11}(\bar{p}-\bar{c})-D_x(x_{11},\theta) \quad \text{(from cond. [G1])}. \end{aligned}$$

Condition (F1) indicates that, for $6=\theta_2$, this expression is strictly negative. If $\theta=\theta_1$, then, since $D_x(x_{11},\theta_2) < D_x(x_{11},\theta_1)$, the expression is again negative. Either way, $h''(\hat{x})=U''(\bullet)(\bar{p}-\bar{c})^2-D_{xx}(\hat{x},\theta)<0 \Rightarrow h'(\hat{x})$ is negative everywhere in the interval $[x_{11},x_{11}+v]$ for $\theta=\theta_1$ or $\theta_2 \Rightarrow h(\hat{x})$ is maximized by producing x_{11}.

Proof of Lemma 2

Similar to the above, using conditions (F3), (F4), (G4), and (H2).

Proof of Proposition 4

From Lemmas 1 and 2, it is sufficient to show that the unique equilibrium involves initial budgets being submitted honestly. Throughout this proof, which comprises six steps, the possibility of agents producing outputs outside their final budgeting ranges is ignored, because of the attendant penalty. For convenience, denote manager A as A1 (A2) when the process is in state θ_1^A (θ_2^A) and likewise for B.

Step 1. Suppose A1's strategies are restricted to budgeting x_1 and refusing (i.e., leaving the firm) and A2's to budgeting x_1, budgeting x_2 and refusing. Then, budgeting x_2^B is a best response for B2 if (and only if) A is truthful (i.e., A1 budgets x_1 and A2, x_2).

For the given set of strategies for A, B2 is indifferent between budgeting x_1^B and x_2^B only when A is truthful; B2 strictly prefers x_1^B in all other cases. Now, when A is honest, x_2^B is weakly preferred to refusing (from cond. [C4]); also, step 2 of this proof shows that it dominates any higher budget. Further, it can be shown with condition (H3) that B2 prefers x_2^B to budgeting in $[x_1^B,x_1^B+v^B]$. Thus, budgeting x_2^B is a best response if (and only if) A is truthful.

Step 2. There is no equilibrium in which A2 or B2 submits a budget in $[x_2,x_2+v]$. A budget of x_2 leads to the same feasible production set as one in $[x_2,x_2+v]$, i.e., $[x_2,x_2+v]$. Further, as:

$$\frac{\bar{K}x}{x_{12}^{j}+x}, \ \frac{\bar{K}x}{x_{2}^{j}+x}, \text{ and } \frac{(\bar{K}+d)x}{x_{12}^{j}+x}$$

are increasing in x, a budget of x_2 yields a lower overhead allocation and thus higher payoffs (for the same disutility) as one in $[x_2,x_2+v]$, regardless of the other agent's strategy. Thus, x_2 dominates any budget in $[x_2,x_2+v]$.

Step 3. There is no equilibrium in which A1 or B1 submits a budget in $[x_2,x_2+v]$. Any manager, say A1, who submits such a budget must budget (and produce) x_2^A. The utility for this is at most $U(R_2)-D(x_2,\theta_1)<\bar{U}^A$ (from conds. [G3], [G4], and [C3]). Budgeting in $[x_2^A,x_2^A+v^A]$ is thus dominated by "refusing," which guarantees $\bar{U}^A$, and so cannot occur in equilibrium.

Step 4. There is no equilibrium in which A1 or A2 submits a budget in $[x_1,x_1+v]$. Suppose not, that is, suppose it is a best response for A1 or A2 to submit $x_1^A+\epsilon$, $\epsilon>0$. Suppose this manager must then resubmit in $[x_{11}^A,x_{11}^A+v^A]$ (an analogous proof holds for the other case). The manager will budget x_{11}^A for an allocation of:

$$x_{11}^A\left(\frac{\bar{K}-b^A+\epsilon}{x_{11}^B+x_{11}^A}\right)$$

and then produce some $x^*\in[x_{11}^A,x_{11}^A+v^A]$. But if the agent were to budget $x_1^A+\mu$ instead, $0<\mu<\epsilon$, a final budget of x_{11}^A would give a lower allocation of:

$$x_{11}^A\left(\frac{\bar{K}-b^A+\mu}{x_{11}^B+x_{11}^A}\right).$$

Producing x^* would then give greater utility, which is contradictory. As ϵ was chosen arbitrarily, the proof is complete.

Step 5. There is no equilibrium in which B2 never budgets x_2^B. Suppose not. From steps 2 and 3 and by hypothesis, B's equilibrium strategies are restricted to refusing or budgeting in the range $[x_1^B,x_1^B+v^B]$. For any strategy that B chooses from these possibilities, A1 strictly prefers an initial budget of $x_1^A+v^A$ rather than x_1^A. From conditions (G1) and (C1) through (C3), A1 also strictly prefers this to refusing. A1's equilibrium response must thus involve choosing a budget from $[x_1^A,x_1^A+v^A]$, contradicting step 4.

Step 6. The unique equilibrium in the game involves the submission of truthful initial budgets. From step 5, any equilibrium must involve B2's choosing x_2^B; from steps 2 through 4, it must involve A's choosing from the strategy set named in step 1. Thus, from step 1, A must be honest in equilibrium. Suppose then that this is the case. As a best response, B1 is indifferent between budgeting x_1^B and refusing; B2 is indifferent between budgeting x_1^B and x_2^B and (possibly) refusing. But, symmetrically, if B chose from among these strategies, A2 would budget x_2^A only if B were honest. The unique equilibrium thus involves both players' budgeting honestly.

Proof of Proposition 5

The stated conditions ensure that the agents receive identical incentive schemes. Then, whenever the fixed resource has the same productivity in both divisions (an event with probability $p_1^A q_1^A + p_2^A (1 - q_2^A) > 0$), the results follow.

Proof of Proposition 6

Given that both agents budget truthfully, the result follows from analysis (using table 1) of the total cost allocated in each of the four possible state realizations.

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Tax Planning, Earnings Management, and the Differential Information Content of Bank Earnings Components

Terry D. Warfield
University of Wisconsin–Madison
Thomas J. Linsmeier
University of Iowa

SYNOPSIS AND INTRODUCTION: This research examines the information content of the bank earnings components entitled "Securities Transactions Gains and Losses" (STGL). STGL reflect the accounting gain or loss that arises when a bank sells an investment security at a price different from the book value. Institutional as well as anecdotal evidence suggests that investors may price STGL differently from the operating earnings component entitled "Income before Securities Transactions" (IBST). For example, prior to 1983, bank regulators viewed the IBST and STGL components as reflecting unique aspects of bank activities and, therefore, required that total bank earnings be disaggregated into IBST and STGL components (SEC 1983). In addition, because of investment market volatility and the discretionary nature of investment securities sales, STGL may convey limited information about current changes in bank value (Linden 1990). Indeed, with banks, security analysts often focus on IBST (Barth et al. 1990), and managers have been accused of selectively selling appreciated investment securities to increase reported levels of accounting earnings (Berton 1991; Wyatt 1991).

Research by Barth et al. (1990) has assessed the relative ability of the

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IBST and STGL income components to explain cross-sectional variation in annual common stock prices. They predicted, for many of the reasons cited above, that the STGL earnings/security price multiple should be less than the multiple assigned to the IBST component. Their results confirm this prediction: IBST played an important role in explaining bank stock prices, but the earnings/security price multiple assigned to STGL did not differ significantly from zero.

There are several reasons why STGL might not have exhibited information content in this research. First, as Barth et al. suggest, the incremental information content of the STGL component may have been diminished because STGL appear to be realized to smooth income. In this situation, STGL are likely to provide little incremental information about changes in bank equity values. Second, Barth et al. measure stock returns over a 12-month interval corresponding to the bank's fiscal year. When returns are measured over such a long period, the likelihood increases that information unrelated to earnings will also be reflected in equity prices, thereby (potentially) reducing the ability of earnings to explain security returns. Third, significant tax-related, cross-sectional differences may exist in the STGL earnings component/security price relationship, and these are "averaged away" when one overall earnings/security price coefficient is estimated. For example, Scholes et al. (1990) suggest that STGL may be realized to minimize taxes. Based on this tax-planning scenario (described in section I), security transaction losses (gains) for tax-paying (non-tax-paying) banks are predicted to be negatively (positively) related to bank equity values.

The objective of this study is to assess whether the STGL earnings component is priced by investors in a manner consistent with this tax-planning rationale. Empirical tests measure the market reaction to IBST and STGL earnings information over the two-day interval consisting of the day before and day of the preliminary quarterly earnings release, and the results provide evidence that STGL are priced by investors in a manner consistent with the tax-planning hypothesis. However, these results appear to hold only in the first three quarters of the fiscal year. In the fourth quarter, there is no evidence that the STGL component is priced by bank investors. These fourth-quarter results are consistent with an increase in earnings-management activity related to STGL near the fiscal year-end

Key Words: *Information content, Earnings components, Security prices, Banking industry.*

Data Availability: *A list of the sample firms and a copy of all data not subject to commercial licensing restrictions are available upon request.*

THE remainder of the article is organized as follows. Section I describes the potential information conveyed by the STGL earnings component. The research design is presented in section II. Section III describes the sample of banks and provides descriptive data on their tax-planning and earnings-management activities. Section IV presents the results. Section V provides concluding remarks.

I. Information Conveyed by Securities Transactions Gains and Losses

The information conveyed by the STGL earnings component may be varied. In general, realized STGL might convey information about unrealized changes in the market value of the current portfolio of investment securities.[1] This information will be price-relevant if realized changes in the value of recently sold investment securities provide unexpected information about either current or future investment returns. In this setting, unexpected STGL are predicted to be positively related to bank equity values.

In addition to this general role in valuation, other economic incentives for realizing STGL might provide different information to bank investors. These incentives are summarized in figure 1, and arise because investment securities are accounted for under an historical cost method. Within this method, realized gains and losses are normally reported as STGL at the time of investment securities sales. Unrealized gains and losses are not recorded in financial statements under this technique. Thus, bank managers can influence the reported level of accounting earnings by managing the timing of investment securities sales.

In general, to maximize the future yield on the investment portfolio, banks may have the incentive to sell the lowest-yielding investment securities whenever liquidity needs arise. However, because the level and volatility of corporate and taxable income are affected by the magnitude of the gain or loss recognized at the time of investment securities sales, bank managers may also have incentives to manage the sale of investment securities to minimize taxes or manage earnings.

Tax Planning

For banks and other financial institutions, STGL give rise to ordinary income or loss rather than capital gain or loss. This tax feature creates the ability to minimize taxes through discretionary timing of investment securities sales because capital losses may offset only capital gains, but ordinary losses can be deducted from the normally larger figure for ordinary taxable income. The exact nature of this tax-planning strategy will depend on the tax-paying status of a bank.[2] For tax-paying banks, the optimal strategy is to sell investment securities that result in losses immediately and to defer indefinitely sale of investment securities that result in gains. The opposite is true for non-tax-paying banks; banks with carryforward benefits from an unexpired net operating loss (NOL) or investment tax credit (ITC) should accelerate (defer) recognition of security transaction gains (losses).

These STGL realization strategies are optimal (assuming nonincreasing future tax rates) because they minimize the present value of tax obligations for tax-paying and non-tax-paying banks.[3] Thus, because tax-paying (non-tax-paying) banks have an economic incentive to realize securities transactions losses (gains), these types of invest-

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[1] Unrealized changes in the market value of investment securities are required to be disclosed as supplemental items in a bank's annual report. However, because a bank's annual report may be released several days (or even several fiscal quarters) after the current quarterly earnings announcement, it is possible that investors will use the STGL earnings information to make a preliminary (but noisy) estimate of unrealized gains or losses.

[2] See Scholes et al. (1990) and Constantinides and Ingersoll (1984) for a detailed description of the tax-planning issues that may affect a bank's timing of investment securities sales.

[3] More specifically, banks can increase the present value of future cash flows by realizing gains in periods when they do not have to pay taxes on taxable income. In addition, the total (i.e., current and future) tax payments for non-tax-paying banks is reduced if carryforward benefits would have expired without current recognition of securities transaction gains. Finally, the recognition of ordinary tax losses by tax-paying banks gives rise to an immediate tax deduction, thereby deferring tax payments from current to future periods.

Figure 1
Information Provided by STGL

Incentives for Realizing STGL	*Nature of Information*	*Effect on Bank Value*
Cash generation (i.e., to meet liquidity needs)	Investment performance	Gains increase and losses decrease value
Tax planning	Tax savings from investment securities sales	Gains for non-tax-paying banks *and* losses for tax-paying banks increase value (other STGL will not result in tax savings)
Income smoothing	Provides little information beyond that provided by IBST	Gains decrease and losses increase value by potentially confirming the opposite-signed IBST component
Regulatory capital planning	Regulatory cost savings from discretionary investment securities sales	Gains for low-capitalization banks increase value (other STGL cannot be used in this manner)

Note: STGL=Securities Transaction Gains or Losses; IBST=Income before Securities Transactions.

ment securities sales should provide good news about future bank value. That is, in these tax settings, transaction losses (gains) should be negatively (positively) related to bank equity values.

The primary objective of this research is to assess whether the STGL earnings component is associated with security returns once the cross-sectional differences predicted by the tax-planning rationale are incorporated into the research design. Our primary tax-planning hypothesis, stated in the null form, is:

> H1: The incremental information content of the STGL income component does not vary with type of realization (i.e., gain or loss) or with the bank's tax position.

Earnings Management

Barth et al. (1990) and Moyer (1990) describe a second set of incentives for realizing STGL. They suggest management may realize STGL to (1) smooth (i.e., reduce the volatility in) the reported level of accounting earnings or (2) alter the current level of regulatory capital. STGL could be used to smooth income if investment securities sales are timed so that, whenever the change in IBST is relatively high (low), the reported level of STGL is relatively low (high). With respect to regulatory capital planning, banks are required to maintain a minimum ratio of primary capital (which is roughly equal to total shareholders' equity plus loan loss reserves) to adjusted gross assets (total assets plus loan loss reserves). When banks realize STGL on their books, they alter the level of their regulatory capital (i.e., gains increase regulatory capital; losses decrease it). Thus, when the regulatory capital ratio is near its nominal minimum of 5 to 5.5 percent, a bank may have the incentive to accelerate (defer) recognition of securities transaction gains (losses) to avoid additional regulatory costs. Note that, for low-capitalization banks, this feature of the reporting environment may provide a disincentive for tax-paying banks to recognize security transactions losses.

STGL that result from earnings-management incentives are likely to convey different information about bank values, relative to STGL realized for tax-planning purposes. Barth et al. suggest that when investment securities sales are used to smooth earnings, STGL will likely have a negative (and possibly insignificant) relationship with bank equity values. In this context, investors will use STGL data primarily to confirm the information provided by the opposite-signed IBST earnings component (i.e., STGL may provide little information beyond that provided by IBST). In contrast, when STGL are used to increase regulatory capital, the regulatory costs of low-capitalization banks should decrease. In this situation, security transaction gains should be positively related to bank equity values. These earnings-management issues will be explored further as we design and interpret tests of the tax-planning hypothesis.

II. Research Design

Empirical Models

The following empirical models provide evidence on the effects of tax-planning incentives on the information content of the STGL earnings component.

$$AR_i = b_0 + b_1 UIBST_i + b_2 USTGL_i + e_i; \tag{1}$$

$$AR_i = c_0 + c_1 UIBST_i + c_2 D_{T,G} \bullet USTGL_i + c_3 D_{T,L} \bullet USTGL_i + c_4 D_{NT,GL} \bullet USTGL_i + e_i, \tag{2}$$

where:

AR_i = two-day abnormal return for bank i cumulated over the day before and day of the relevant quarterly earnings announcement in *The Wall Street Journal,*

$UIBST_i$ = unexpected quarterly IBST for bank i, which is defined during the announcement quarter q as $[IBST_{iq} - E(IBST_{iq})]/MV_i$,

$USTGL_i$ = unexpected quarterly STGL for bank i, which is defined during the announcement quarter q as $[STGL_{iq} - E(STGL_{iq})]/MV_i$,

MV_i = market value of equity for bank i on the day prior to the AR_i cumulation period,

$E(\bullet)$ = the market's earnings expectation immediately prior to the earnings release. Specification of the expectations for each earnings component are discussed later in this section.

$D_{T,G}, D_{T,L}$, and $D_{NT,GL}$ = dummy variables that classify each sample observation into one of three categories;

$D_{T,G}$ equals 1 if a non-tax-paying bank receives a tax advantage (T) by recognizing a security transaction gain (G) during quarter q; otherwise, it equals 0;[4]

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[4] Banks' tax status was determined on the basis of data in tax footnotes in the most recent annual reports. The majority of this data was provided by Scholes et al. (1990), and our classification is similar to theirs. If a bank reported a NOL or ITC carryforward benefit during the current fiscal year, it was classified as non-tax-paying. All other banks were classified as tax-paying. If tax footnote data were unavailable (< 10 observations), then we assumed, like Scholes et al. (1990), that the bank was a tax-paying bank.

$D_{T,L}$	equals 1 if a tax-paying bank receives a tax advantage (T) by recognizing a security transaction loss (L) during quarter q; otherwise, it equals 0;
$D_{NT,GL}$	equals 1 if a bank receives no tax advantage (NT) from recognizing either a security transaction gain (G) or security transaction loss (L) during quarter q; otherwise, it equals 0;
e_i	is a regression residual assumed to be distributed i.i.d. normal;
b_0, c_0	are estimates of the mean abnormal return in the announcement period in absence of an information release; and
$b_1, b_2, c_1, c_2, c_3, c_4$	are the earnings response coefficients for the respective income components that, in cross-section, reflect the average incremental effect on abnormal returns due to the release of the component information.

Regression estimates of equation (1) provide benchmark evidence on the market reaction to bank earnings components, and, as in Barth et al. (1990), this can be used to determine if the IBST and STGL earnings components are priced differently by investors. Within this formulation, we expect the coefficient b_1 on *UIBST* to be positive because, as indicated by prior research, past levels of operating earnings provide information about a firm's ability to generate future operating earnings (and, hence, cash flows). In equation (1), no prediction can be made about the sign of b_2 because the USTGL variable might be either positively or negatively related to bank equity values, depending on the firm's economic context (e.g., recall the tax-planning incentives in figure 1).

With respect to the primary research hypothesis, equation (2) is designed to assess whether cross-sectional differences arise in the incremental information content of the STGL earnings component in conformance with the tax-planning rationale. Dummy variables are used in equation (2) to segregate STGL transactions that are incurred to minimize taxes from those incurred for other purposes. The tax-motivated transactions are identified by two different variables in equation (2). The first—the $D_{T,G}$ variable—identifies transactions that are expected to be positively associated with bank equity values (i.e., security transaction gains for non-tax-paying banks). The second—the $D_{T,L}$ variable—is expected to exhibit a negative relationship with bank equity values because it identifies security transaction losses for tax-paying banks. The last dummy variable—$D_{NT,GL}$—identifies STGL that are realized for non-tax reasons.

Three sets of statistical tests will be used to provide evidence related to the tax-planning hypothesis. First, an incremental F-test will be used to assess whether the explanatory power (i.e., the R^2) of equation (2) is greater than that of equation (1). A statistically significant change in model R^2s indicates that the STGL earnings component is priced differently by investors, depending on the tax effect of STGL realizations. Second, *t*-tests will be used to assess whether the sign and statistical significance of each regression coefficient arise in a manner consistent with the tax-planning rationale (i.e., c_2 should be > 0 and c_3 should be < 0). Note that in equation (2) the c_1 coefficient on *UIBST* is still expected to be positive. STGL associated with c_4 do not arise for tax-motivated reasons, but might be positively related to abnormal returns if they were realized as a result of investment portfolio liquidity transactions (see fig. 1). Finally, if the STGL realized for tax-minimization purposes provide information distinctly different from that of other STGL, then we might expect the coefficients on the tax-savings variables (i.e., c_2 and c_3) to be significantly different from the coefficient on the non-tax-related variable (i.e., c_4). Thus, the final set of statistical tests related to the tax-planning hypothesis will test the null hypotheses that $c_2=c_4$ and $c_3=c_4$.

Measurement of Variables

Abnormal Returns and Earnings Data. Abnormal returns are estimated by deducting a benchmark return from the realized return in the period examined. To remove market wide effects on security returns, the benchmark return is calculated with the parameter estimates from a single (value-weighted) index market model regression estimated over a 200-day period centered on the earnings release date. These estimates are then combined with the observed value-weighted market return in the earnings release period to yield the benchmark return.[5] Realized earnings components are obtained from the COMPUSTAT bank file. These amounts were verified against the actual earnings numbers reported in the *Value Line Investment Survey* and *The Wall Street Journal*. Discrepancies were found in 47 cases, but inferences did not change when these observations were deleted.

IBST and STGL Earnings Expectations. Analysts' earnings forecasts provided by the *Value Line Investment Survey* are used to formulate the market's expectation for IBST.[6] Brown et al. (1987a, 1987b) show that analyst forecasts are superior to time-series forecasts of quarterly earnings expectations. A different expectation model must be used for STGL because analysts do not normally provide forecasts of STGL. This may be because market participants (including analysts) find it difficult to anticipate accurately the amount of STGL to be reported by a bank in any given quarter. Thus, a reasonable assumption may be that the market has no expectation about the amount of STGL to be reported in any given bank quarter. Indeed, excerpts found in *Value Line* reports highlight the relative uncertainty associated with the STGL earnings component. Thus, like Barth et al., we use a zero-expectation model for STGL.[7]

III. Sample and Descriptive Data

Sample

The empirical tests of the tax-planning hypothesis are conducted at quarterly earnings announcement dates throughout the period 1980–85. Each of the 47 banks that issued the 745 quarterly earnings announcements included in the sample met the following requirements for data availability: (1) financial statement data on the COMPU-

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[5] The primary inferences from our research remain unchanged when abnormal returns were measured with: (1) a two-index market model that controls for interest rate changes as well as for marketwide returns, (2) a single-index market model that employs an equally weighted rather than value-weighted index, and (3) a benchmark based on mean-adjusted returns.

[6] It should be noted that *Value Line* provided forecasts only of IBST prior to 1983. Then, as a consequence of the 1983 change in format for income statement reporting (described in fn. 8), *Value Line* began to provide forecasts of total bank net income primarily. This could be an important distinction. However, because we assume that STGL are expected to be zero in any given quarter, the *Value Line* forecasts of either net income or IBST were used interchangeably throughout our sample period.

[7] Consider, e.g., the following quotes from *Value Line* reports: (1) there is "no way to forecast the results of securities transactions . . ." (PNC Financial, April 1983) and (2) "volatile components of non-interest income such as bond trading profits are just as likely to go up next quarter as they were down last quarter" (Mercantile Texas, October 1985). To assess whether a more accurate market expectation for STGL could be based on the economic conditions faced by a bank in a particular quarter, we developed a regression model for predicting STGL similar to that employed in Moyer (1990). Forecasts from the zero-expectation model were found to be marginally superior to those of this regression model. See Warfield (1989) for details.

Table 1
Sample Selection

	Banks	*Bank Quarters*
Banks with relevant data available on 1986 quarterly COMPUSTAT tape during the sample period, 1980–85	132	3,168
Less: Banks with missing daily returns on relevant CRSP tapes	<22>	<528>
Less: Banks without *Value Line* forecasts for at least four consecutive quarters	<63>	<1,512>
Usable observations from public sources	47	1,128
Less: Observations for which earnings component detail was unavailable at the preliminary earnings announcement date		<375>
Less: Influential observations with a confounding event at the earnings announcement date		<8>
Final number of sample observations		745

STAT bank tape from 1979 to 1985, (2) daily security returns on either the CRSP or NASDAQ return files for the 200 days surrounding the earnings release dates during 1980–85, (3) *Value Line* earnings forecasts for at least four consecutive quarters during the test period, 1980–85.

These sampling criteria yielded an initial sample of 1,128 quarterly earnings announcements. From this total, 375 announcements were deleted because STGL data were not provided in preliminary earnings releases during the 1983–85 period.[8] We arrive at the final sample (745 observations) after deleting eight observations that (1) were identified as "influential" according to the influence diagnostics of Belsley et al. (1980), and (2) had confounding events (e.g., changes in capital structure) announced during the event period. These deletions were made to ensure that the regression results would not be unduly influenced by confounding events. Table 1 provides a summary of the sample selection criteria.

Descriptive Statistics: Tax Planning

Panel A of table 2 contains descriptive statistics for the abnormal returns (*AR*) and unexpected earnings (*UIBST* and *USTGL*) variables for the full sample of 745 observa-

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[8] Prior to 1983, details about the IBST and STGL components were automatically disclosed in preliminary earnings releases because banks were required to prepare a "two-step" income statement in which total bank income was explicitly disaggregated into IBST and STGL. Since 1983, the Securities and Exchange Commission has required banks to prepare a more traditional "one-step" income statement, and component details are no longer a required disclosure at the time of the preliminary earnings release. Thus, during the 1983–85 period, we verified that component information was available at the time of each earnings release in our sample by examining actual bank news releases or data disclosed in either *The Wall Street Journal* or the PRNEWS file in the NEXIS service.

Table 2
Descriptive Statistics for Selected Variables

	Panel A: Full Sample (N=745)			*Panel B: Tax-Paying Banks with Security Transaction Losses* (N=341)			*Panel C: Non-Tax-Paying Banks with Security Transaction Gains* (N=96)			*Panel D: Other Banks Not Receiving a Tax Advantage from Security Transactions* (N=308)		
	AR	*UIBST*	*USTGL*	*AR*	*UIBST*	*USTGL*	*AR*	*UIBST*	*USTGL*	*AR*	*UIBST*	*USTGL*
Mean	0.0006	−0.0009	−0.0019	0.0008	0.0003	−0.0056	−0.0031	−0.0079	0.0026	0.0016	−0.0002	0.0008
Standard deviation	0.026	0.018	0.031	0.026	0.008	0.045	0.029	0.041	0.008	0.025	0.013	0.005
Percentiles:												
100	0.1222	0.0978	0.0496	0.0891	0.0200	−0.0000	0.1222	0.0667	0.0496	0.0791	0.0978	0.0331
75	0.0141	0.0035	0.0003	0.0142	0.0035	−0.0004	0.0129	0.0047	0.0018	0.0142	0.0031	0.0009
Median	0.0001	0.0000	−0.0001	−0.0007	0.0003	−0.0016	−0.0050	−0.0005	0.0004	0.0023	0.0000	0.0001
25	−0.0134	−0.0033	−0.0018	−0.0134	−0.0020	−0.0040	−0.0200	−0.0081	0.0001	−0.0115	−0.0034	0.0000
0	−0.1510	−0.3472	−0.8310	−0.1510	−0.0856	−0.8310	−0.0805	−0.3472	0.0000	−0.1400	−0.1222	−0.0273
Product-Moment Correlations:												
UIBST	0.176***	—	—	0.140**	—	—	0.103	—	—	0.358***	—	—
USTGL	−0.058	0.144***	—	−0.102*	0.576***	—	0.141	−0.155	—	0.079	−0.100*	—

Notes: The banks in panel D include non-tax-paying banks with security transaction losses (N=65) and tax-paying banks with security transaction gains (N=243). *AR* (the dependent variable) is the two-day abnormal return cumulated over the day before and day of the earnings announcement. The independent variables are *UIBST*, unexpected income before security transactions, and *USTGL*, unexpected security transaction gains or losses. All independent variables are per share amounts scaled by the closing price on the day preceding the announcement period. Market expectations for IBST are based on the most recent *Value Line* analyst forecast prior to the earnings announcement. Market expectations for STGL are assumed to be zero.

* $p<0.10$.
** $p<0.01$.
*** $p<0.001$.

tions. The means for *UIBST* and *USTGL* are both negative. For the *UIBST* variable, this suggests that, on average, analysts are optimistic in their earnings projections, which is consistent with findings of prior research (see, e.g., Brown et al. 1987a). For the *USTGL* variable, the negative mean appears to be caused by some very large security transaction losses for tax-paying banks (see panel B of table 2). This is preliminary evidence consistent with the tax-planning rationale.[9]

Further evidence on the use of STGL for tax-planning purposes is provided in panels B, C, and D of table 2. These panels show the distributions of, and pairwise correlations between, the *AR*, *UIBST*, and *USTGL* variables conditional on the tax incentive classifications used in equation (2). There are 341 sample observations for tax-paying banks with security transaction losses, and 96 observations associated with non-tax-paying banks with security transaction gains. The remaining 308 observations are for banks that receive no tax advantage from realizing STGL. This latter group can be further subdivided into 65 (243) observations for non-tax-paying (tax-paying) banks recognizing security transaction losses (gains).

The number of observations within the tax status categories are consistent with the tax-planning rationale. Tax-paying banks recognized more security transaction losses (341) than gains (243). Correspondingly, non-tax-paying banks recognized more security transaction gains (96) than losses (65). Additional evidence of preliminary support for the tax-planning hypothesis is found by comparing the average gain and loss values of the *USTGL* realized by tax-paying and non-tax-paying banks. The mean *USTGL* loss for tax-paying banks of −0.0056 is larger in absolute magnitude than the average *USTGL* loss of −0.0030 (not reported in table 2) for non-tax-paying banks. Thus, banks which receive a tax advantage from loss realization realize larger losses than banks that received no such advantage. Similarly, the average *USTGL* gain for non-tax-paying banks of 0.0026 is larger than the *USTGL* gain of 0.0019 (not reported in table 2) for tax-paying banks, thereby documenting that banks realize larger gains when taxes are not paid.

Finally, pairwise correlations between *AR* and either *UIBST* or *USTGL* also yield expected results. In each instance of a significant correlation between an unexpected earnings variable and abnormal returns, the correlation statistic exhibits the predicted sign (see table 2). These results, especially the negative and significant correlation between *AR* and *USTGL* for tax-paying banks with security transaction losses, provide the final evidence in table 2 consistent with the tax-planning rationale.

Descriptive Statistics: Earnings Management

Although the primary tests in this study assess the implications of tax planning for the information conveyed by STGL, prior research suggests that earnings-management incentives also exist and may confound these results. In this section, we provide evidence on the relevance of these factors for the tests of the tax-planning hypothesis reported in section IV.

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[9] It also should be noted that the distribution of the unexpected earnings variables are negatively skewed with minimum values 19 to 27 standard deviations below their sample means (see panel A of table 2). To assess the sensitivity of our results to these extreme observations, we reestimated each of the regression models in table 3 after truncating extreme *UIBST* and *USTGL* observations to values five standard deviations from their sample means. To diminish the effects of outlier observations, we calculated each sample standard deviation after deleting the first and 99th percentiles of the variable distributions. Inferences related to our primary research hypotheses remained unchanged following these procedures.

Income Smoothing. Barth et al. (1990) show that bank managers realize STGL to reduce the volatility in (i.e., smooth) *annual* earning levels. In particular, they document this behavior by comparing annual median changes in IBST with annual median levels of STGL. For 76 percent of their sample years, when the annual median change in IBST was above (below) its overall median, the median level of STGL was below (above) its overall median. In addition, they show that the correlation between the median yearly percentage change in IBST and the annual median level of STGL (scaled by IBST) is -0.40, which is significant at the 5 percent level. In contrast, bank managers in our sample appear less likely to use STGL to offset unusual changes in *quarterly* levels of IBST. For example, when the quarterly median change in IBST was above (below) its overall median for the 1980–85 sample period, the quarterly median level of STGL was below (above) its overall median 68 percent of the time. In addition, the correlation between the quarterly median change in IBST and the quarterly median level of STGL (both scaled by price) is -0.26. This correlation is not significant at traditional levels.

These weaker test results are not completely unexpected because, although banks can manage earnings by manipulating STGL, a different accounting adjustment—the loan loss provision—is probably a better smoothing device.[10] The loan loss provision (LLP) possesses three properties relative to STGL that make it especially appropriate for purposes of earnings management. First, its magnitude is typically much larger than the reported level of STGL. For example, in our sample, the average LLP is 7.2 times than the average absolute value of STGL. Second, there is a large discretionary component to LLPs (Beaver et al. 1989; Moyer 1990), just as there is for STGL. Third, a change in the LLP accrual adjustment has no direct effect on future bank cash flows, whereas a sale of investment securities may result in foregone future investment returns (Moyer 1990). Given these reasons, banks may be more likely to use LLPs to smooth earnings throughout the fiscal year and to use STGL only for marginal adjustments near the fiscal year-end. Therefore, we hypothesize that *STGL-related* smoothing behavior will be more prevalent during the fourth quarter than during the prior quarters in the fiscal year.

Evidence consistent with this hypothesis is provided by our sample of firms. During the fourth quarter, 100 percent of the median reported levels of STGL were above (below) their overall median when the corresponding median change in IBST was below (above) its overall median. In contrast, the median behavior of the IBST and STGL variables during the first three fiscal quarters was consistent with the smoothing hypothesis only 56 percent of the time. In addition, the correlation between individual firm-quarter changes in IBST and individual firm-quarter levels of STGL (both scaled by price) is seven times greater in the fourth quarter (-0.14; $p<0.10$) than in the prior fiscal quarters (-0.02; $p>0.10$). Thus, for our sample, it appears that STGL are most likely to be used to smooth earnings near the fiscal year-end.[11]

Regulatory Capital Planning. A second earnings-management incentive can arise from potential effects of regulatory capital planning associated with STGL realization.

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[10] See Worthy (1984, 52–53) for anecdotal evidence from the early 1980s that banks often smooth earnings by making adjustments to their loan loss provisions.

[11] Statistics were also calculated to assess the degree of income smoothing with LLPs. For 83 percent of the fiscal quarters, the median change in LLPs was found to be above (below) their overall median when the corresponding median quarterly change in IBST before deducting LLPs was below (above) its overall median. In

Moyer (1990) shows that, in general, other accounting adjustments (e.g., LLPs) are better mechanisms for regulatory capital planning.[12] Yet, as in income smoothing, it may be that certain banks will use STGL realizations as a cost-effective mechanism for managing regulatory capital in selected time periods. That is, on the margin, only low-capitalization banks (e.g., banks with ratios below their regulatory minimum) may be likely to accelerate (defer) recognition of securities transactions gains (losses). In addition, these adjustments may be cost-effective only in the fourth quarter, when other, less costly accounting adjustments, like LLPs, have already been made.

Evidence from our sample supports this hypothesis. The average fourth quarter gain (scaled by price) recognized by low-capitalization banks is 1.85 times larger than the average gain recognized in the prior three quarters. In addition, the average fourth-quarter loss recognized by low-capitalization banks is only 42 percent of the average loss recognized in the first three fiscal quarters. No such difference is found for high-capitalization banks (i.e., banks with ratios above their regulatory minimum) or in other fiscal quarters. Thus, when regulatory capital is low, banks may have an additional incentive to manage the timing of investment securities sales. However, this incentive appears to be most prevalent in the fourth fiscal quarter.

Implications for Research Design. The evidence suggests that our tests of the tax-planning hypothesis are most likely to be confounded by STGL-related earnings-management activities during the fourth quarter of the fiscal year. For this reason, we also estimate equations (1) and (2) after segregating fourth-quarter earnings releases from the prior three quarters to determine if the *USTGL*/security price relationship will differ between the fourth and other fiscal quarters. Note that this segregation of sample observations will be useful in designing "cleaner" tests of our tax-planning hypothesis only if banks do not undertake tax-planning activities exclusively in the fourth fiscal quarter. Fortunately, investment market volatility is likely to induce bank managers to sell investment securities throughout the fiscal year because tax advantages may disappear as securities' values change.[13]

IV. Results

Regression Results on the Full Sample

Table 3 presents the results from estimating equations (1) and (2) with all 745 bank quarter observations. The results for equation (1) provide the first evidence of the infor-

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addition, the correlation between the median quarterly change in IBST (before LLPs) and the median quarterly change in LLPs (both scaled by price) is quite large (−0.85) and is statistically significant at the 0.001 level. Finally, no difference in LLP-related smoothing behavior is found between the fourth and prior three fiscal quarters. These statistics provide further evidence that banks are more likely to use LLPs to smooth earnings and that this behavior occurs throughout the fiscal year.

[12] E.g., Moyer (1990) provides evidence that, on average, annual LLP adjustments had a much larger effect on bank regulatory capital ratios in the 1981–86 period than did STGL. In addition, unexpected LLP were significantly associated with the level of regulatory capital whether banks were close to their capital minimum or not. In contrast, STGL were associated with the level of regulatory capital only for selected time periods or banks (e.g., banks with low regulatory capital).

[13] The finance literature (see, e.g., Reinganum 1983) suggests that tax-loss selling of investment securities may be concentrated near the fiscal year-end. However, this evidence is less relevant to the bank setting because the commonly cited tax incentive for this behavior does not apply to financial institutions. For banks and other financial institutions, STGL always give rise to ordinary income or loss rather than capital gain or loss (see sec. I).

Table 3
Regression Results for All Quarterly Announcements during the Sample Period, 1980–85
(N=745)

Coefficient Estimates
(t-statistics in parentheses; predicted signs in brackets)

Model	*Intercept* [?]	*UIBST* [+]	*USTGL* [?]	$D_{T,G}$ • *USTGL* [+]	$D_{T,L}$ • *USTGL* [−]	$D_{NT,GL}$ • *USTGL* [+]	R^2(%)
(1)	0.001 (0.79)	0.269 (5.19)***	−0.071 (−2.34)*				3.82
(2)	0.0003 (0.29)	0.297 (5.65)***		0.662 (2.02)**	−0.088 (−2.85)**	0.505 (1.78)**	4.99

F-tests for changes in R^2:

Model 1 vs. Model 2: $F=5.30$**

Model 2 vs. [Model 2 where the coefficient on $D_{NT,GL}$ • *USTGL*=coefficient on $D_{T,L}$ • *USTGL*]: $F=4.31$*

Model 2 vs. [Model 2 where the coefficient on $D_{NT,GL}$ • *USTGL*=coefficient on $D_{T,G}$ • *USTGL*]: $F=0.13$

Notes: Regression coefficients are obtained from the following regression models (firm subscripts are suppressed):

(1) $AR=b_0+b_1 UIBST+b_2 USTGL+e$
(2) $AR=c_0+c_1 UIBST+C_2 D_{T,G} \bullet USTGL+C_3 D_{T,L} \bullet USTGL+C_4 D_{NT,GL} \bullet USTGL+e$

where *AR* is the two-day abnormal return cumulated over the day before and day of the earnings announcement; *UIBST* is unexpected income before security transactions; *USTGL* is unexpected security transaction gains or losses; $D_{T,G}=1$ for banks that avoid taxes by incurring a security transaction gain (otherwise=0); $D_{T,L}=1$ for banks that save taxes by incurring a security transaction loss (otherwise=0); $D_{NT,GL}=1$ for banks with no tax advantage related to the incurrence of a security transaction gain or loss (otherwise=0); and, e is the regression disturbance term.

Significance levels for *t*- and F-statistics: $*<0.05$; $**<0.01$; and $***<0.001$. (The reported significance levels for the *t*-statistics are one-tailed except for each intercept and for *USTGL* in Model 1, which are two-tailed.)

mational usefulness of the IBST and STGL components. Results for the individual IBST and STGL variables in equation (1) suggest that both earnings components are valuation-relevant at the earnings announcement date. The coefficient on *UIBST* is positive, as predicted, and significant at the 0.001 level, while the coefficient estimate on *USTGL* is negative and significant with a p-value of less than 5 percent.[14] The negative and significant coefficient for *USTGL* may be consistent with the tax-planning hypothesis, but only if tax-paying banks with security transaction losses dominate the regression results. Evidence in this regard is provided by estimating equation (2).

The equation (2) estimation also contains results related to the primary research hypothesis and supports the tax-planning rationale. The explanatory power of equation (2) with an R^2 of 4.99 percent exceeds that of equation (1), R^2 of 3.82 percent, and is statistically different from that of equation (1) at $p<0.01$ ($F=5.30$). Thus, by conditioning the specification of the *USTGL* variable on a bank's tax status and the sign of reported STGL, we are able to explain a greater portion of the cross-sectional variation in abnormal returns during the earnings announcement period.

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[14] It also should be noted that the R^2 of 3.82 percent for equation (1) is greater than the R^2 of 0.13 percent for a regression model that constrains the b_1 and b_2 coefficients to be equal ($F=27.60; p<0.001$). This provides evidence that bank investors price the STGL and IBST earnings components differently from total net income.

The coefficient estimates in equation (2) for each of the earnings components have the predicted signs and are significant at conventional levels. This result is further evidence for the tax-planning hypothesis because, as predicted, c_2 is significantly greater than zero, and c_3 is significantly less than zero. The positive and significant c_4 coefficient suggests that STGL realized for non-tax reasons may provide positive signals about investment performance. Of course, other explanations might exist for the latter result (see fig. 1). However, as suggested by our descriptive statistics on earnings management (see sec. III), these other explanations are more likely during the fourth fiscal quarter. Results reported in the next section indicate that the c_4 coefficient remains positive and significant when equation (2) is estimated after deleting fourth-quarter data.

Finally, if STGL realized for tax-minimization purposes provide information distinctly different from that of other STGL, then we might expect a statistically significant difference between c_4 and either c_3 or c_2. Incremental F-tests that assess the statistical difference in model R^2s when the coefficients in equation (2) are unconstrained versus when c_4 is constrained to be equal to either c_3 or c_2, show that $c_4 \neq c_3$ ($F=4.31$; $p<0.05$) but that $c_4=c_2$ ($F=0.13$). This provides evidence that security transaction losses for tax-paying banks are valued differently by investors than are STGL realized for non-tax reasons. In contrast, security transactions gains for non-tax-paying banks are not valued differently from non-tax-motivated STGL. However, the magnitude of c_2 is greater than that of c_4. This result would be predicted if security transaction gains for non-tax-paying banks give an additional tax-related increment to bank cash flows when compared to non-tax-related STGL.[15]

Regression Results Segregating the Fourth Quarter from Other Fiscal Quarters

Table 4 presents results with fourth-quarter data segregated from data in the other fiscal quarters. The objective of this analysis is to determine whether the increased likelihood of using STGL to smooth income or manage regulatory capital during the fourth fiscal quarter causes the earnings component/security price relation to differ across fiscal quarters. Panel A contains results from regressions estimated with data from the first three fiscal quarters, and these are quite comparable to the results in table 3. In fact, the inferences that would be made on the basis of the results reported in panel A of table 4 are identical to the inferences that were made from table 3; thus, these inferences will not be reiterated.[16]

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[15] Several diagnostic tests were undertaken to assess the robustness of inferences based on the full sample results from equation (2). These include adjustments for nonlinearities and heteroskedasticity in the data. In addition, we assess the stability of coefficient estimates using leave-one-out jackknifing and robust regression techniques. Finally, an unexpected LLP variable was added to the regression to determine if it was a significant correlated omitted variable. Our primary inferences did not change as a result of any of these modifications.

[16] The regressions with the fourth quarter segregated from other fiscal quarters were also reestimated after truncating extreme *UIBST* and *USTGL* observations to values five standard deviations from their means. The inferences related to our primary research hypotheses again remain unchanged. The one exception is the test for whether $c_4=c_2$, which is rejected at the 0.10 significance level when equation (2) is estimated with data from the first three fiscal quarters only. This result provides evidence that security transaction gains for non-tax-paying banks may provide an additional tax-related increment to their cash flows, in comparison with non-tax-related STGL.

Table 4
Regression Results with Fourth-Quarter Earnings Announcements Separated from the Prior Quarters during the Sample Period, 1980–85

Panel A. Regression Results for Non-Fourth-Quarter Data (N=556):

Coefficient Estimates
(t-statistics in parentheses; predicted signs in brackets)

Model	*Intercept* [?]	*UIBST* [+]	*USTGL* [?]	$D_{T,G}$ • *USTGL* [+]	$D_{T,L}$ • *USTGL* [−]	$D_{NT,GL}$ • *USTGL* [+]	R^2(%)
(1)	0.001	0.286	−0.077				4.78
	(1.23)	(5.01)****	(−2.42)***				
(2)	0.001	0.327		1.142	−0.094	0.953	7.10
	(0.52)	(5.68)****		(2.62)***	(−2.97)***	(2.31)**	

Panel B. Regression Results for Fourth-Quarter Data (N=189):

Coefficient Estimates
(t-statistics in parentheses; predicted signs in brackets)

Model	*Intercept* [?]	*UIBST* [+]	*USTGL* [?]	$D_{T,G}$ • *USTGL* [+]	$D_{T,L}$ • *USTGL* [−]	$D_{NT,GL}$ • *USTGL* [+]	R^2(%)
(1)	−0.001	0.191	0.170				
	(−0.43)	(1.43)*	(0.76)				1.28
(2)	−0.0002	0.176		−0.091	0.388	0.097	
	(−0.10)	(1.27)*		(−0.19)	(1.07)	(0.26)	1.64

Panel C. F-tests for Change in R^2:

	Non-Fourth-Quarter Regressions	*Fourth-Quarter Regressions*
Model 1 vs. Model 2:	*F*=6.73***	*F*=0.34
Model 2 vs. Model 2 where the coefficient on $D_{NT,GL}$ • *USTGL*=coefficient on $D_{T,L}$ • *USTGL*:	*F*=6.35***	*F*=0.31
Model 2 vs. Model 2 where the coefficient on $D_{NT,GL}$ • *USTGL*=coefficient on $D_{T,G}$ • *USTGL*:	*F*=0.10	*F*=0.09

Notes: See table 3 for description of the regression models.

Significance levels for *t*- and *F*-statistics: *<0.10; **<0.05; ***<0.01; and ****<0.001. (The reported significance levels for the *t*-statistics are one-tailed except for each intercept and *USTGL* in Model 1, which are two-tailed values.)

In contrast, the results for the fourth fiscal quarter in panel B of table 4 are quite different from the results for the prior three fiscal quarters. In particular, there is no support for the tax-planning rationale in panel B of table 4. The R^2 of equation (2) is not statistically different from that of equation (1) (*F*=0.34). In addition, none of the *USTGL* coefficients in equation (2) are statistically different from zero. Thus, the tax-planning incentive does not appear to be the primary reason STGL are realized in the fourth fiscal quarter. Further, earnings management also does not appear to be the *predominant* motivation for STGL realization in this fiscal quarter. If STGL were primarily realized to manage regulatory capital in the fourth fiscal quarter, we would expect a positive and significant coefficient on *USTGL* in equation (1). This is not the case ($b_2=0.170$, $t=0.76$).[17] In addition, if STGL were realized to smooth income in the fourth fiscal quarter, we would expect a negative and possibly insignificant coefficient on *USTGL* in equation (1). Although this coefficient is insignificant, it does not have a negative sign. Thus, banks' economic incentive for realizing STGL in the fourth fiscal quarter cannot be determined from the regression results reported in panel B of table 4. Of course, these insignificant results for STGL could be attributed to an increase in STGL-related earnings-management activity that produces offsetting effects on security returns in the fourth fiscal quarter.

V. Summary and Conclusions

The incremental information content of earnings components may vary, depending on the economic conditions faced by a firm. In the banking industry, this may be especially true for the STGL earnings component. Prior research has suggested that STGL may be realized to minimize taxes or to manage earnings (Barth et al. 1990; Scholes et al. 1990). The analysis in this article has hypothesized that tax minimization is an important incentive for realizing STGL and that this should affect the information conveyed by the STGL earnings component. Tests were designed to determine whether the STGL earnings component is priced by investors in a manner consistent with these tax incentives.

We find that the IBST and STGL earnings components are priced differently by bank investors. In addition, we document cross-sectional differences in the STGL earnings/security price relation that are consistent with tax planning and inconsistent with earnings-management incentives for realizing STGL. Thus, the information conveyed by the STGL earnings component varies, depending on the economic conditions faced by the firm. These results are important as additional evidence that the information content of accounting disclosures may be highly contextual in nature. In addition, they suggest the importance of identifying and incorporating such contextual factors in tests of the information content of accounting earnings.

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[17] We also ran a regression model similar to equation (2) but with an additional dummy variable to identify low-capitalization banks that realized security transaction gains. The objective of this extra regression term was to determine whether security transaction gains were positively related with abnormal returns for low-capitalization banks in the fourth fiscal quarter. This is the effect predicted in figure 1 in connection with STGL realization for regulatory capital-planning reasons. Although this regulatory capital-planning coefficient is larger than the other *USTGL* coefficients reported for equations (1) and (2) in panel B of table 4, it is still not statistically different from zero (coefficient = 0.826; t-statistic = 0.85). Thus, little capital market evidence is provided to support a conclusion that regulatory capital planning is a primary incentive for realizing STGL in the fourth fiscal quarter.

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Financial Statement Information and the Pricing of Earnings Changes

Stephen H. Penman
University of California at Berkeley

SYNOPSIS AND INTRODUCTION: This study adds to recent research that assesses the value implications of earnings changes. Stock price changes associated with reported earnings innovations (typically assessed by estimating earnings response coefficients) have been characterized as related to the persistence of earnings, which is defined as the revision in expected future earnings that is implied by a current earnings innovation. Permanent earnings innovations are associated with higher multipliers than transitory ones.

This stream of research stems from Kormendi and Lipe (1987) and Easton and Zmijewski (1989). These studies characterize earnings persistence as a stationary, firm-specific phenomenon that describes the evolution of earnings over time. They estimate parameters of earnings persistence from time-series data on earnings and then show that the market's pricing of earnings innovations are related to the persistence measures. Typically, this evaluation involves *ex post* information, so the approach is not relevant for investors' *ex ante* determination of pricing multipliers.

This article reports three findings on the pricing of annual earnings changes. First, pricing multipliers can be evaluated contemporaneously by other information published in annual financial statements along with earnings. An investor who seeks to assess persistence and the price effect of a reported earnings change can do so by referring to other information in the financial statements.

Second, in contrast to previous research, this study shows that the earnings persistence indicated by financial statements is not a fixed attribute, but changes over time and tends to revert to the mean of all firms. Correspondingly, pricing multipliers follow a similar pattern, which requires their periodic updating through financial statement analysis.

Third, the multiplier of earnings changes is also related to information published in the previous year's annual report. To the extent that previous accounting reports provide forecasts of earnings that are already incorporated in prices, multipliers are lower.

The comments of the referees are much appreciated.

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Data Availability: *Financial statement data are available from the author subject to licensing restrictions by COMPUSTAT and CRSP.*

THE presentation proceeds as follows. Section I outlines the differences between this study and previous research. Section II describes the accounting information that indicates earnings persistence, and section III describes the data. Section IV demonstrates how contemporaneous and leading accounting information explains the pricing of earnings innovations. A short summary of the article is provided in section V.

I. Contrast with Previous Research

This study differs from previous research in its characterization of "persistence" and in its specification of the earnings variable for which pricing multipliers are estimated. Most previous research[1] considers earnings persistence as a permanent, firm-specific characteristic of the earnings process. Correspondingly, earnings response coefficients are estimated as firm-specific constants.

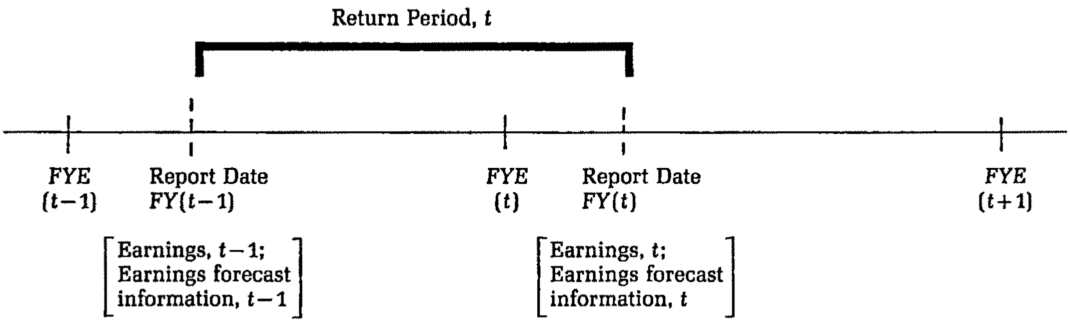
This parametric approach has several problems. To begin with, the construction of earnings persistence as a time-series parameter raises concerns about context validity. Current earnings innovations are deemed persistent to the extent that they are indicative of expected future earnings; otherwise, they are transitory. Projecting future earnings from information limited to the earnings time series does not utilize other information that a rational investor would use to assess persistence. Given this consideration, persistence (and thus earnings multipliers) are identified by the discovery of information that projects future earnings. As this information changes over time, so does the persistence of successive earnings realizations. Thus the assumption of stationarity implicit in the parametric approach is not appropriate.

Accounting statements provide an array of line items other than earnings. This article shows that this information contributes to the evaluation of persistence and the pricing of earnings innovations. The line items change over time and so do persistence measures and pricing multipliers.

Persistence parameters, as typically estimated, are not *ex ante* indicators of earnings pricing. These parameters and the pricing multipliers they imply are usually estimated in time series over the same period. Thus multipliers evaluated at any point prior to the end of the estimation period use persistence measures estimated from data later in time. The predictive ability of parametric persistence measures has not been demonstrated, and thus one must question whether the reported association between persistence measures and pricing multipliers is merely a result of statistical overfitting. With the exception of Jennings (1988a, 1988b), there is little research into the *ex ante* determinants of persistence and multipliers. In contrast, the persistence measures obtained from line-item analysis can be used in investment analysis.

[1] For example, Kormendi and Lipe (1987), Easton and Zmijewski (1989), Collins and Kothari (1989), and Lipe (1990).

Figure 1
Relevant Accounting Information for Pricing an Earnings Innovation for Fiscal Year *t*


Return Period, *t*
FYE (*t*−1)
Report Date FY(*t*−1)
FYE (*t*)
Report Date FY(*t*)
FYE (*t*+1)
Earnings, *t*−1; Earnings forecast information, *t*−1
Earnings, *t*; Earnings forecast information, *t*

Note: *FYE* = fiscal year-end; *FY* = fiscal year.

The study also differs from previous research in the specification of the earnings variable. Most previous work estimates pricing multipliers by relating contemporaneous stock returns (standardized price changes) to standardized unexpected earnings. In this study, actual earnings changes are evaluated, rather than unexpected earnings. This is done for two reasons. First, investors infer value from observed accounting numbers (and other information), not unexpected numbers. Thus, the present research examines the pricing implications of observable, reported earnings changes, and how that might differ with different financial statement information. Second, the specification permits the explicit recognition of prior accounting information in the task of evaluating earnings.

The second point is explained with reference to figure 1. After the end of fiscal year *t*, designated as *FYE*(*t*), an annual report for the year is published, and investors assess the pricing implication of the reported earnings change. This is evaluated here by observing returns over the period indicated in the figure. The primary finding is that this evaluation depends on other information in the financial statement for year *t*, which forecasts earnings for year *t*+1 and beyond and thus gives an indication of whether the reported earnings will persist. However, this will also depend on information in financial reports for year *t*−1, which forecast the earnings change in year *t* being evaluated. To the extent that those earnings are forecasted at the beginning of the return period, they will be discounted by the market, and a lower multiplier will be applied.

This approach is compatible with the logic of specifying unexpected earnings as the variable of interest because they discount the earnings number for beginning-of-period forecast information. It is also compatible with the view that multipliers of earnings changes are conditional on the information in price (at *t*−1) that leads earnings (see, e.g., Collins and Kothari 1989). However, the approach here permits explicit examination of the incoming information that determines the multiplier of *actual* earnings changes. This is apparently what Lipe (1990) has in mind by suggesting that earnings response coefficients are affected by information, other than earnings, that predicts earnings. In sum, the multiplier is described as determined by accounting information at the end of the period that indicates persistence of the current earnings, and by accounting information at the beginning of the period that already has informed the investor about the forthcoming reported earnings. In assessing the weight to put on an observed earnings change, an investor would consider both sets of information.

II. Financial Statement Indicators of Future Earnings

Ou (1990) an Ou and Penman (1989a, 1989b) have identified financial statement line items that project future earnings. These items are evaluated on their ability to predict the direction of one-year-ahead earnings (minus a drift estimate) and are then combined into a scalar, Pr. This ranges from zero to 1 and is an estimate of the probability of a one-year-ahead earnings increase conditional upon available financial statement information. Formally, for firm *i* in fiscal year *t*,

$$Pr_{it} = \text{Probability}[(\Delta eps_{it+1} - \textit{estimated eps drift}_{it+1})] > 0, \tag{1}$$

given financial statement information, which is assumed to be generated by the logistic distribution such that,

$$Pr_{it} = [1 + \exp\{-y_{it}\}]^{-1},$$

where:

$$y_{it} = \sum_{j=1}^{n} \theta_j X_{jit}.$$

The X_{jit} are the identified accounting items from the annual report, and θ_j is the weight for the *j*th item. Coefficients are estimated (from data pooled over firms in periods prior to year $t+1$) by using LOGIT with the dependent variable as the increase or decrease in one-year-ahead earnings over the estimated drift. This drift is estimated as the mean changes in earnings per share (eps) in the preceding four years to obtain a predictable trend in eps.

A *Pr* value of 0.5 from financial statement information predicts future earnings at the level of current earnings, which indicates that the current earnings change will have a persistent effect. For *Pr* values away from 0.5 (toward zero or unity), financial statement information indicates that current earnings are not representative of future earnings and, on average, are different from the past as well (Ou and Penman 1989b). That is, these *Pr* values identify earnings that are temporarily high or low (i.e., transitory). This indicates that *Pr* is a suitable summary of information in financial statements about persistence and the earnings change multiplier. The accounting items included in estimating *Pr* are listed in the Ou and Penman articles. They include inventories, capital expenditures, depreciation, dividends, book value of equity, and sales, with most of them standardized in ratio calculations.

III. Data

The analysis is carried out over the 11 years, 1973–83, for which *Pr* values were calculated in Ou and Penman (1989a). The number of firms in each year varied from 1,482 to 1,677. *Pr* values were calculated for firms with the relevant accounting data in the COMPUSTAT annual and research files. For each year, the coefficients that were applied to the accounting variables to obtain *Pr* were estimated in prior periods, so estimated *Pr* is always an *ex ante* measure. Stock returns and prices were obtained from CRSP files. The final sample is representative of the industry composition on COMPUSTAT, with the exception that there are relatively few electric and gas utilities and financial firms.

IV. Earnings Multipliers and Financial Statement Information

This section presents the results in three sub-sections. First, it documents the relationship between earnings multipliers and persistence information that is published in financial statements along with earnings (for *FYE*(*t*) in fig. 1). Secondly, it demonstrates that indications of persistence in financial statements vary in time and, correspondingly, so do earnings multipliers. Finally, it describes the effect of prior accounting information (for *FYE*(*t*−1) in fig. 1) on the multiplier.

The analysis involves the estimation of a simple cross-sectional regression equation of the form,

$$R^a_{it} = a_t + b_t \Delta eps_{it}/P_{it-1} + u_{it}, \qquad (2)$$

for each year of the sample period. Estimates of the multiplier, b_t, are then compared over different *Pr* values. R^a_{it} is the market-adjusted rate of return on the stock of firm *i* over the 12-month period during which the change in annual *eps* (before extraordinary items) in fiscal year *t* (Δeps_{it}) is reported.[2] This 12-month period begins in month four of the relevant fiscal year and ends three months after the end of the year, the period during which earnings and *Pr* information are published in the annual report. The Δeps_{it} and the price changes plus dividends in the calculation of the dependent variable, R^a_{it}, are standardized by P_{it-1}, the price per share at the beginning of the 12-month period. The coefficient, b_t, is a multiplier of dollar changes in earnings and is referred to as an earnings change multiplier.[3] The subscript indicates that it varies in time.

Multipliers and Contemporaneous Information

In each year, firms are identified with one of ten groups, according to the Pr_{it} ranges in the second column of table 1. The first panel of table 1 presents findings for these groups. The second panel summarizes results for combined groups 1, 2, 9, and 10 (with $Pr_{it}>0.8$ or $Pr_{it}\leq 0.2$), groups 3, 4, 7, and 8 (with $0.8\geq Pr_{it}>0.6$ or $0.4\geq Pr_{it}>0.2$), and groups 5 and 6 (with $0.6\geq Pr_{it}>0.4$). For easy reference, these groups are labeled 11, 12, and 13, respectively. This clustering is based on the distance of Pr_{it} from its central value of 0.5. The results from pooling all observations are in group 14.

In addition to estimated earnings multipliers, table 1 summarizes attributes of Pr_{it} groups that demonstrate properties of Pr. Of particular interest are the mean values of $\Delta eps_{it}/P_{it-1}$ and $\Delta eps_{it+1}/P_{it}$. Pr_{it}, which is an earnings predictor, orders one-year-ahead earnings changes, $\Delta eps_{it+1}/P_{it}$. However it inversely orders contemporaneous

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[2] The market adjustment to returns is unnecessary if all firms have the same fiscal year-end. However, for a given calendar year, firms with different fiscal year-ends are pooled. Thus, the dependent variable return covers different calendar periods. Results were similar when unadjusted returns were used as the independent variable with only December 31 fiscal-year firms.

[3] This terminology distinguishes it from an "earnings response coefficient" applied to unexpected earnings in other studies.

Table 1
Estimated Earnings Change Multipliers and Other Attributes of Pr_{it} Groups

Pr_{it} Group	Range of Pr_{it}	No. of Firms	Mean Pr_{it}	Mean $\Delta eps_{it}/P_{it-1}$	Mean $\Delta eps_{it+1}/P_{it}$	$\bar{\hat{\gamma}}_{it}$	$t(\bar{\hat{\gamma}}_{it})$	No. $\hat{\gamma}_{it}>0$	$\bar{a}_t$	$t(\bar{a}_t)$	$\bar{b}_t$	$t(\bar{b}_t)$	Mean R^2	No. $\hat{b}_t>0$	Mean $\hat{\beta}_{it}$
1	$Pr_{it}>.9$	571	.95	−.2176	.1827	−.360	−4.16	0	−.123	−3.86	.364	5.15	.11	11	1.14
2	$.9\geq Pr_{it}>.8$	884	.85	−.1043	.0864	−.334	−4.70	1	−.103	−5.13	.395	7.00	.10	11	1.08
3	$.8\geq Pr_{it}>.7$	2,120	.74	−.0161	.0296	−.078	−1.27	4	−.048	−3.96	.617	7.36	.11	11	1.06
4	$.7\geq Pr_{it}>.6$	4,264	.65	.0175	.0034	.078	1.61	8	−.025	−1.86	1.080	6.76	.15	11	1.04
5	$.6\geq Pr_{it}>.5$	4,690	.55	.0285	−.0051	.010	.17	6	−.021	−1.48	1.451	8.28	.16	11	1.03
6	$.5\geq Pr_{it}>.4$	2,922	.46	.0439	−.0088	.078	1.49	8	−.027	−2.68	1.839	6.61	.19	11	1.01
7	$.4\geq Pr_{it}>.3$	1,128	.36	.0546	−.0225	−.060	−.80	5	−.029	−1.82	1.461	5.59	.15	11	1.00
8	$.3\geq Pr_{it}>.2$	394	.26	.0609	−.0277	.040	.23	6	−.062	−2.32	2.262	5.46	.34	11	1.09
9	$.2\geq Pr_{it}>.1$	146	.16	.0934	−0.367	−.332	−2.54	2	.079	1.86	1.129	2.63	.24	8	1.11
10	$Pr_{it}\geq.1$	76	.05	.1072	−0.151	−.198	−1.36	4	−.017	−.22	1.073	2.66	.25	6	1.25
11	$Pr_{it}>.8;$ $Pr_{it}\leq.2$	1,677	.77	−.1080	.0981	−.377	−6.35	0	−.066	−3.50	.473	7.84	.14	11	1.11
12	$.8\geq Pr_{it}>.6;$ $.4\geq Pr_{it}>.2$	7,906	.61	.0164	.0049	−.021	−.46	5	−.017	−1.54	.963	8.50	.14	11	1.04
13	$.6\geq Pr_{it}>.4$	7,612	.52	.0337	−.0062	.031	.68	7	−.022	−1.77	1.556	9.07	.17	11	1.00
14	All Pr_{it}	17,195	.59	.0113	.0097	−.160	−5.23	0	−.011	−1.22	.894	9.07	.13	11	1.00

Notes: All means values are calculated from those observed for each of the 11 years 1973–83 (i.e., they are the means of annual means).

$\Delta eps_{it}/P_{it-1}$ is the change in earnings per share for firm i for fiscal year t, deflated by per-share stock price at the end of the third month of fiscal year t.

The estimations for group 10 involve small numbers of firms in some years.

$\bar{\hat{\gamma}}_{it}$ is the mean estimate of γ_{it} in equation (3); $\bar{a}_t$ and $\bar{b}_t$ are mean estimates of a_t and b_t in equation (2) over years; $\hat{\beta}_{it}$ is estimated systematic risk for each stock in the group.

earnings changes, $\Delta eps_{it}/P_{it-1}$. Thus, as in Ou and Penman (1989b), Pr_{it} identifies ex *ante* earnings reversals; for high *Pr* values current earnings are down but will be up in the future (on average), and vice versa. For Pr values away from 0.5, the current earnings change produces a transitory level of earnings. This is the behavior of a mean-reverting (non-persistent) innovation.[4]

To demonstrate this point further and to indicate a correspondence between Pr_{it} and the parameters of earnings persistence that were estimated in previous studies, equation (3) was estimated each year for each Pr_{it} group:[5]

$$\Delta eps_{it+1}/P_{it} = \gamma_{0t} + \gamma_{1t}\Delta eps_{it}/P_{it-1} + v_{it+1}. \tag{3}$$

The coefficient, γ_{1t}, is an earnings revision parameter (in the language of Easton and Zmijewski 1989) estimated from matched pairs of sequential earnings changes in the cross-section within each Pr_{it} group rather than from a time-series. The *t* subscript connotes time-varying rather than firm constants. Mean values of $\hat{\gamma}_{1t}$ over the 11 years are given in table 1 with values of $t(\bar{\gamma}_{1t})$.[6] These coefficients are different over the Pr_{it} groups.[7] For groups with Pr_{it} close to 0.5, values of $\bar{\gamma}_{1t}$ are close to zero. Financial statement information incorporated in Pr_{it} indicates future earnings at current levels, and thus current earnings are persistent. In contrast, for Pr_{it} values away from 0.5, the values for $\bar{\gamma}_{1t}$ are increasingly negative with the distance from 0.5. The value of $\bar{\gamma}_{1t}$ and $t(\bar{\gamma}_{1t})$ for the extreme Pr_{it} values in group 11 are −0.377 and −6.35, respectively, indicating considerable mean reversion in earnings. Here, the changes in expected future and current earnings are different. The revision parameter is negative, which indicates transitory changes in current earnings that are likely to be reversed in the future. In short, Pr_{it} is a measure of "earnings persistence."

Table 1 reports $\bar{b}_t$, the mean estimate of the cross-sectional slope coefficient in equation (2) for each Pr_{it} group over the 11 years, the associated *t*-statistic, mean estimated intercepts, $\bar{a}_t$ and *t*-statistics, and means values of adjusted R^2. The number of $\hat{b}_t$ observed as positive in the 11 years is also indicated. These multipliers differ over Pr_{it} groups in a similar way to $\hat{\gamma}_{1t}$. For all firms (gp.14), the mean value of $\hat{b}_t$ is 0.894. However, for Pr_{it} close to 0.5 (gp. 13), the estimated values are considerably higher, but decline for Pr_{it} values away from 0.5.

The significance of these differences is demonstrated by estimating (for each year with observations for all firms) an equation of the form,

$$\begin{aligned} R^a_{it} = {} & a_{0t} + a_{1t}D_{1it} + a_{2t}D_{2it} + b_{0t}\Delta eps_{it}/P_{it-1} + b_{1t}D_{1it}\Delta eps_{it}/P_{it-1} \\ & + b_{2t}D_{2it}\Delta eps_{it}/P_{it-1} + w_{it}, \end{aligned} \tag{4}$$

where D_{1it} is equal to 1 if a firm's Pr_{it} value is in group 12, and zero otherwise, and D_{2it} is equal to 1 if a firm's Pr_{it} value is extreme (in gp. 11), and zero otherwise. Over the 11 years, the value of $\bar{\bar{b}}_{0t}$ was 1.556 ($t=9.07$), which corresponds to the estimated multiplier for earnings reported with Pr_{it} close to 0.5 (gp. 13). The value of $\bar{\bar{b}}_{1t}$ was -0.594 ($t=-6.22$) and $\bar{\bar{b}}_{2t}$ was -1.084 ($t=-8.04$).[8] The mean adjusted R^2 for the regression was 0.16. Earnings change multipliers differ significantly over levels of Pr_{it} in a direction that is consistent with the market's incorporating the persistence information in Pr. The implication for accounting and financial statement analysis is that earnings multipliers can be derived from information, other than earnings, that is in financial statements.

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[4] Pr identifies earnings reversals in part because of the subtraction of the "drift" term in equation (1). This takes out predictable drift in eps (e.g., due to earnings retention). However, it compares future earnings changes with past earnings changes so that, if earnings do have a mean-reverting element, the implied earnings reversals will be identified by the specification.

[5] The estimations in table 1 (and elsewhere) reject outliers when the absolute value of $\Delta eps_{it}/P_{it-1}$ is greater than a predetermined 1. The results are not sensitive to this rejection rule.

[6] All *t*-statistics reported for estimated regression coefficients are calculated as the mean of the yearly cross-sectional coefficient estimates divided by their estimated standard error calculated from the time series of estimated coefficients.

[7] Tests indicated that these differences are statistically significant.

Although these findings indicate that earnings multipliers are lower for Pr_{it} values different from 0.5, a comparison of estimated multipliers, over Pr_{it} groups 1 through10, indicates an asymmetry. Estimates of b_t are relatively low for high Pr_{it} values but not consistently so for low Pr_{it} values, although there is considerably more variation in coefficient estimates for low values, as indicated by the t-statistics. Further tests indicated that mean estimated multipliers for the most extreme low Pr_{it} values in groups 9 and 10 are significantly lower than those in groups 5 and 6, but only marginally so; however, those for groups 7 and 8 are not.[9] Further, mean R^2 values are higher for low Pr values than for high ones, although the variation in R^2 is greater.[10] This asymmetry is unexplained. Of course 46 percent of the sample falls in the high Pr_{it} groups (1–4) and only 10 percent in the low Pr_{it} groups (7–10), so when extreme Pr_{it} values are identified, they are associated with low multipliers a high proportion of the time.

Easton and Zmijewski (1989) characterize pricing multipliers as negatively related to risk and positively related to earnings persistence. The last column of table 1 gives mean betas for Pr_{it} groups estimated over a period of up to 60 months prior to year t. Extreme Pr_{it} are associated with higher betas than average, so this may be the reason they imply lower multipliers. However, equation (4) was estimated for a number of partitions on estimated beta, and coefficient estimates were quite similar over these partitions. For example, for firms whose estimated beta is greater than 1, $\bar{\bar{b}}_{1t}$ is -0.507 ($t=-3.16$) and $\bar{\bar{b}}_{2t}$ is -1.209 ($t=-6.44$); the corresponding values for firms whose estimated beta are less than or equal to 1 are -0.561 (-5.63) and -0.927 (-6.21), respectively. Indeed, the relationship between estimated coefficients and estimated betas is not a strong one. Estimating equation (4) with D_{1it} set to 1 if $\hat{\beta}_{it} \geq 1.5$ and D_{2it} set to 1 if $\hat{\beta}_{it} < 0.5$ (and zero otherwise) produced $\bar{\bar{b}}_{1t}$ of 0.050 ($t=0.67$) and $\bar{\bar{b}}_{2t}$ of 0.257 ($t=1.05$), and similar results were found with other beta ranges. Of course, measurement error in $\hat{\beta}_{it}$ biases these estimates toward zero, and beta risk presumably does not capture all aspects of firm risk that determine discount rates.[11]

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[8] The estimated first-order serial correlations of $\hat{b}_{0t}$, $\hat{b}_{1t}$, and $\hat{b}_{2t}$ are -0.048, 0.114, and -0.039, so the assumption of serially uncorrelated coefficients implicit in the calculation of the t-statistics (see fn. 6) appears to be satisfied.

[9] When equation (4) was estimated with observations in groups 5 through 10 only, the estimate of $\bar{\bar{b}}_{1t}$ (gps. 7 and 8) was 0.123, with a t-statistic of 0.64, and the estimate of $\bar{\bar{b}}_{2t}$ (gps. 9–10) was -0.533 with a t-statistic of -1.87. The latter is significant at the 0.05 level for a one-tailed test.

[10] For groups 1, 2, and 3, the ranges of R^2 values are 0.03 to 0.23, 0.02 to 0.24, and 0.06 to 0.20, respectively. For groups 8, 9, and 10 the respective ranges are 0.02 to 0.58, 0.0 to 0.62, and 0.01 to 0.63.

[11] The dependent variable in equation (2) is not adjusted for risk, so both earnings changes and returns (relative to the market) may reflect common return factors (see Freeman 1987b). Adding $\hat{\beta}_{it}$ as a control variable in equation (2) did not significantly change estimates of earnings multipliers, however.

Table 2
Mean Values of Attributes of Pr_{it} Groups in Years Following Pr_{it} Year

	Year (j) Following Year t				
Group	t+j (j=1)	t+j (j=2)	t+j (j=3)	t+j (j=4)	t+j (j=5)
Panel A. Mean Earnings Persistence Measures, Pr_{ij}:					
1	.73	.64	.59	.57	.59
2	.72	.65	.60	.58	.60
3	.68	.64	.60	.58	.57
4	.62	.61	.58	.56	.56
5	.56	.57	.56	.56	.55
6	.51	.54	.56	.56	.57
7	.46	.52	.54	.56	.55
8	.46	.54	.57	.57	.58
9	.43	.53	.57	.61	.61
10	.48	.58	.65	.65	.61
Panel B. Mean Standardized Earnings Changes, $\Delta eps_{ij}/P_{ij-1}$:					
1	.1827	.0607	.0571	−.0104	−.0372
2	.0864	.0624	.0341	.0114	−.0319
3	.0296	.0355	.0320	.0135	−.0030
4	.0034	.0181	.0211	.0112	.0073
5	−.0051	.0045	.0084	.0117	.0108
6	−.0088	−.0040	−.0008	.0021	.0140
7	−.0225	−.0154	−.0044	.0089	.0145
8	−.0277	−.0262	.0106	.0177	.0030
9	−.0367	−.0226	−.0485	.0308	.0376
10	−.0151	−.0290	−.0532	.0370	.0708
Panel C. Mean Estimated Earnings Autoregressive Coefficients, $\bar{\bar{\gamma}}_{1j}$, $(t(\bar{\bar{\gamma}}_{1j}))$:					
11	−.015	−.167	−.194	−.021	−.220
	(−2.99)	(−2.47)	(−3.31)	(−.54)	(−3.08)
12	−.221	−.168	−.134	−.185	−.104
	(−6.12)	(−4.10)	(−3.61)	(−2.56)	(−3.17)
13	−.134	−.126	−.146	−.105	−.216
	(−3.81)	(−5.33)	(−3.01)	(−1.94)	(−1.84)
14	−.160	−.154	−.152	−.142	−.162
	(−5.54)	(−5.18)	(−4.39)	(−3.30)	(−2.97)
Panel D. Mean Estimated Earnings Change Multipliers, $\bar{\bar{b}}_j(t(\bar{\bar{b}}_j))$:					
11	.513	.728	.843	.819	.897
	(8.29)	(5.10)	(5.20)	(4.76)	(4.01)
12	1.017	.923	.923	.921	.903
	(7.89)	(7.09)	(6.73)	(6.00)	(4.44)
13	1.227	.913	.890	.985	1.012
	(8.30)	(7.11)	(6.35)	(5.13)	(5.02)
14	.866	.867	.888	.899	.916
	(8.47)	(7.54)	(7.00)	(6.06)	(5.02)

Note: Pr_{it} groups are defined in the second column of table 1. For the meaning of $\bar{\bar{\gamma}}_{1t}$ and $\bar{\bar{b}}_t$, refer to the notes in table 1.

Time-Series Variation in Earnings Change Multipliers

This section demonstrates that persistence measures and estimated earnings change multipliers vary over time. This complements findings in earlier research. Not only do earnings change coefficients (estimated over time) vary cross-sectionally, but also, for a given firm, vary over time. Information in financial statements tracks this variation.

Panel A of table 2 presents mean *Pr* values for firms in each of the ten *Pr* groups (formed in year *t*) for each of the five following years, $t+j$, $j=1,2,\ldots,5$.[12] Although some mean reversion is expected if Pr values are measured with error in the base year *t*, the results indicate that *Pr* is not a permanent characteristic of firms. Positive serial correlation in *Pr* is evident, but the cross-sectional variation in mean *Pr* across the groups disappears by year $t+3$, and all values in this year are close to those in table 1 for all firms (gp. 14) in year *t*. The mean estimated Spearman rank correlations between portfolio mean *Pr* values in year *t*, and those in year $t+j$, $j=1,2,\ldots,5$, are 0.87, 0.67, 0.28, −0.03, and 0.22, respectively. The associated *t*-statistics are significant at the .05 level in years $t+1$ to $t+3$ only.

Mean reversion in the indicators of earnings persistence is supported by the displays in panels B and C of table 2. Panel B gives mean standardized earnings changes for the ten Pr_{it} groups for years $t+j$, $j=1,2,\ldots,5$. Earnings reversals are evident from year *t* to $t+1$ for Pr_{it} groups away from 0.5 (table 1), but not in subsequent years. Up to year $t+3$, earnings changes in table 2 are rank-ordered over levels of Pr in the same direction as in year $t+1$.[13] *Pr* indicates future reversals (transitory current earnings), but not as a continuing phenomenon. (Incidentally, the ordering of the changes in *eps* in years $t+1$ to $t+5$ indicates that *Pr* predicts earnings changes for up to three years ahead.) Panel C gives mean estimated earnings revision parameters, $\bar{\bar{\gamma}}_{ij}$, for years following year *t* for *Pr* groups 11, 12, and 13, as well as for all firms combined (gp. 14). Unlike those for year *t* in table 1, these values are similar over the *Pr* groups and similar to those for all firms (gp. 14), which indicates that differential earnings revision parameters are indicated only by current *Pr* values.[14] The parameter describing the transition from one earnings innovation to the next is time-varying, and its variation is described by contemporaneous financial statement information.

Panel D of table 2 presents the mean estimated multipliers of earnings changes, $\bar{\bar{b}}_j$, for Pr_{it} groups 11 through 14 for each year $t+j$, $j=1,2,\ldots,5$. With the exception of group 11 for year $t+1$, these mean values are quite similar over groups 11 through 13 in all years following year *t*, and are similar to those for all firms in group 14, as indicated by significance tests performed by estimating equation (4) in the relevant years. The findings are in contrast to those for year *t* in table 1: the multipliers are time-varying and revert to those of the typical firm.[15]

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[12] Values for each $t+j$ are pooled over calendar years. The table reports means of mean Pr values for those years. As Pr values are calculated for a fixed period of time, 1973–83, the number of firm-years in the calculation declines as *j* increases, and the precision in the mean values also declines. Results are similar when the analysis is for year $t+j$ when that year is 1983 or a prior year. Thus, the firms in the calculation for year $t+j$ are the same as the firms in year *t*.

[13] The reversal in the other direction in year $t+5$ is not explored here.

[14] These inferences are supported by statistical tests similar to those conducted in the estimation of equation (4).

[15] Further tests revealed that the central tendency in multipliers over time is primarily identified with firms in groups 1 through 4, rather than those in groups 7 through 10. This is expected, given that multipliers for groups 7 through 10 are closer to the central value in year 0 (as indicated in table 1).

This evidence indicates that the earnings persistence captured by Pr measures is not a permanent characteristic of firms. Transitory earnings indicated by Pr dissipate quickly. Correspondingly, earnings valuation multipliers also change over time. A practical implication is that financial statement analysis needs to be updated annually to identify transitory earnings and adjust multipliers.

Earnings Change Multipliers and Prior Information

In table 1, earnings multipliers are evaluated with contemporaneous financial statement information. This information (for year t) predicts earnings for $t+1$. Similar information in financial statements for year $t-1$ will predict earnings for year t. Thus, the market valuation of earnings changes in year t may be affected by prior financial statement information. To the extent that earnings are predicted by that information (and that information is reflected in price prior to the return period), reported earnings will be discounted and earnings multipliers will be lower.

Panel A of table 3 evaluates this description. Earnings multipliers are evaluated not only by the contemporaneous Pr value (Pr_{it}, indicated by rows in table 3), but also by the prior year's Pr value (Pr_{it-1}, indicated by column headings). The analysis is based on years 1974–83 because no Pr values are available prior to 1973, and the number of Pr groups is reduced to four to provide a reasonable number of observations in each cell. Panel B of the table provides mean values of the deflated earnings ($\Delta eps_{it}/P_{it-1}$) along with the number of observations in each cell (in parentheses).[16]

Panel B shows that, just as Pr_{it} is negatively related to contemporaneous earnings changes (in year t) for a given level of Pr_{it-1} (reading down the columns), Pr_{it-1} is positively related to earnings changes in year t for a given level of Pr_{it} (reading across the rows). This describes the ability of Pr_{it-1} to predict earnings in t. Correspondingly, multiplier estimates in panel A are related not only to Pr_{it} but also to Pr_{it-1}. When Pr_{it} is held constant (in a given row in table 3), estimated multipliers differ over Pr_{it-1} (displayed over columns).[17] The significance of the differences over Pr_{it-1} is assessed by estimating equation (4) for each row of the table. The mean estimates of b_{1t} and b_{2t} are given in the last two columns of panel A. Except when $Pr_{it}>0.8$ (for which the estimated multipliers are low for all Pr_{it-1} values), significant differences are observed and indicate that prior financial statement information affects the pricing of one-year-ahead earnings changes.

If multipliers are related to prior Pr values and Pr values are positively serially correlated, the lower multipliers for the extreme Pr_{it} values noted earlier could be attributable to extreme Pr_{it-1}, that is, prior prices will have discounted the earnings. However, within a given column in panel A of table 4, earnings change multipliers vary over Pr_{it} with controls for Pr_{it-1}. The mean estimates of b_{1t} and b_{2t} in equation (4) reported in the rows of panel A provide the appropriate significance tests.

In summary, earnings change multipliers are evaluated with both contemporaneous and leading financial statement information. Evaluating the pricing of earnings as it evolves over time involves assessing how financial statement information also

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[16] The pattern of the observation count over cells in panel B (with fewer observations off the diagonal) is due to the serial correlation in Pr that is indicated in panel A of table 2.

[17] The control for Pr_{it} while analyzing values over Pr_{it-1} (and vice versa) may not be perfect, given the positive serial correlation of Pr values. However, mean values of Pr_{it} across rows in table 3 were approximately the same (with the exception, of course, of the "All Pr_{it}" row) as were mean values of Pr_{it-1} displayed down columns.

Table 3
Estimated Earnings Change Multipliers (Panel A) and Standardized Earnings Changes (Panel B) for Joint Pr_{it} and Pr_{it-1} Groups

Values of Pr_{it}	Values of Pr_{it-1}					
	$Pr_{it-1}>.8$	$.8\geq Pr_{it-1}>.6$	$.6\geq Pr_{it-1}>.4$	$Pr_{it-1}\leq .4$	$\bar{\bar{b}}_{1t}$	$\bar{\bar{b}}_{2t}$
Panel A. Mean Estimated Earnings Change Multipliers, $\bar{\bar{b}}_t$:						
$Pr_{it}>.8$	.335 (5.57)	.433 (6.19)	.252 (1.17)	.605 (2.60)	.057 (.62)	.000 (.00)
$.8\geq Pr_{it}>.6$	.576 (5.66)	1.103 (7.04)	.919 (6.15)	1.067 (4.96)	.129 (1.07)	−.450 (−3.49)
$.6\geq Pr_{it}>.4$	.622 (3.56)	1.729 (7.33)	2.096 (8.66)	1.431 (4.30)	−.288 (−2.04)	−1.526 (−6.67)
$Pr_{it}\leq .4$	.408 (1.10)	1.134 (2.50)	2.267 (5.09)	1.859 (4.04)	−.793 (−2.53)	−1.374 (−3.49)
All Pr_{it}	.500 (8.18)	.982 (7.79)	1.227 (8.30)	1.115 (6.97)	−.206 (−3.46)	−.780 (−7.23)
$\bar{\bar{b}}_{1t}$	−.075 (−.44)	−.586 (−3.97)	−.687 (−4.59)	−.230 (−.81)		
$\bar{\bar{b}}_{2t}$	−.361 (−2.22)	−1.205 (−5.97)	−1.455 (−7.08)	−.609 (−1.95)		
Panel B. Mean Standardized Earnings Changes, $\Delta eps_{it}/P_{it-1}$:						
$Pr_{it}>.8$	−.0138 (418)	−.1911 (561)	−.3302 (215)	−.2182 (85)		
$.8\geq Pr_{it}>.6$	.2142 (486)	.0126 (3047)	−.0569 (1650)	−.0675 (209)		
$.6\geq Pr_{it}>.4$	.2249 (167)	.0694 (1805)	.0191 (4232)	−.0275 (644)		
$Pr_{it}\leq .4$	.0724 (49)	.1297 (193)	.0725 (708)	.0203 (654)		
All Pr_{it}	.1276 (1120)	.0125 (5606)	−.0053 (6805)	−.0262 (1592)		

Note: Figures in parentheses in panel A are *t*-statistics on the mean multiplier estimates, and those in panel B are the number of observations in the respective cells, pooled over years.

evolves over time. Strikingly, the market's valuation of earnings changes is high for the intersection of $0.6\geq Pr_{it-1}>0.4$ and $0.6\geq Pr_{it}>0.4$, where the mean $\bar{b}_t$ is 2.096. Here current and prior financial statements provide little information about the direction of future earnings. In both the current and preceding year, one-year-ahead earnings are expected to be the same as the most recently observed earnings (as described in a "random walk" characterization of earnings), so the observed change is deemed an unpredicted, permanent addition to the level of earnings. Thus, significant weight is placed on the current earnings change in valuation. The estimated multipliers generally decline as Pr_{it} and Pr_{it-1} values radiate out from this central cell in the table,

Table 4

Estimated Earnings Change Multipliers (Panel A) and Standardized Earnings Changes (Panel B) for Joint Pr_{it} and E_{it-1}/P_{it-1} Groups

Values of Pr_{it}	E_{it-1}/Pr_{it-1} Group 1 (Low)	2	3	4	5 (High)	$\bar{\bar{b}}_{1t}$	$\bar{\bar{b}}_{2t}$
Panel A. Mean Estimated Earnings Change Multipliers, $\bar{\bar{b}}_t$:							
$Pr_{it}>.8$	.380 (5.08)	.798 (4.76)	.719 (2.82)	.121 (.64)	.299 (1.92)	−.108 (−.73)	−.189 (−1.32)
$.8 \geq Pr_{it}>.6$	.665 (6.20)	1.472 (3.58)	1.934 (5.55)	1.719 (6.78)	1.051 (7.30)	−.367 (−1.68)	−1.206 (−3.94)
$.6 \geq Pr_{it}>.4$	.808 (4.82)	3.011 (5.55)	2.467 (6.06)	2.460 (6.32)	1.785 (8.04)	.097 (.27)	−1.067 (−2.89)
$Pr_{it} \leq .4$	1.344 (4.40)	2.567 (4.75)	2.199 (3.72)	2.800 (3.61)	1.410 (5.61)	.200 (.52)	−.370 (−.72)
All Pr_{it}	.594 (8.20)	1.511 (6.63)	1.496 (7.02)	1.383 (7.94)	1.190 (7.61)	−.053 (−.32)	−.731 (−4.64)
$\bar{\bar{b}}_{1t}$	−.052 (−.36)	−.988 (−2.04)	−.374 (−.80)	−.573 (−2.03)	−.560 (−4.42)		
$\bar{\bar{b}}_{2t}$	−.346 (−2.35)	−1.920 (−4.04)	−1.701 (−5.14)	−1.893 (−5.24)	−1.159 (−6.58)		
Panel B. Mean Standardized Earnings Changes, $\Delta eps_{it}/P_{it-1}$:							
$Pr_{it}>.8$	−.0852 (622)	−.1476 (201)	−.1880 (147)	−.2586 (125)	−.3473 (178)		
$.8 \geq Pr_{it}>.6$	.1133 (1256)	−.0015 (1014)	−.0058 (989)	−.0231 (1036)	−.0861 (1090)		
$.6 \geq Pr_{it}>.4$	.1218 (636)	.0306 (1356)	.0280 (1521)	.0273 (1579)	.0122 (1750)		
$Pr_{it} \leq .4$	.1535 (178)	.0505 (414)	.0519 (330)	.0516 (293)	.0430 (385)		
All Pr_{it}	.0744 (2692)	.0123 (2985)	.0093 (2987)	.0018 (3033)	−.0358 (3403)		

Note: Figures in parentheses in panel A are t-statistics on the mean multiplier estimates, and those in panel B are the number of observations in the respective cells, pooled over years. E_{it-1}/P_{it-1} is the earnings price ratio at the beginning of the return period covered by the dependent variable in equation (2).

demonstrating the sensitivity of earnings multipliers to contemporaneous and leading financial statement information.[18]

Because the financial statement information summarized in Pr_{it-1} probably does not contain all prior information, prior price might be a more thorough control to use when assessing multipliers from current Pr. Prior price presumably summarizes more information about future earnings than is available in prior financial statements. Therefore, table 4 repeats the analysis in table 3 except that prior information about earnings is indicated by leading E_{it-1}/P_{it-1} rather than Pr_{it-1}.

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[18] The asymmetry of estimated multipliers over high and low Pr values observed in table 1 is evident here also.

Beaver and Morse (1978) and Ou and Penman (1989b) demonstrate that earnings/price (E/P) ratios, in the cross section, differentiate one-year-ahead earnings changes, so that, when E/P ratios differ from normal, prices indicate that earnings will be different from current earnings. Thus five E_{it-1}/P_{it-1} groups replace the Pr_{it-1} groups in the column headings of table 4. These are formed for each year from a ranking of firms on E_{it-1}/P_{it-1} at the beginning of the return period.[19] The ability of E/P ratios to differentiate one-year-ahead earnings changes is borne out by comparisons of mean earnings changes across rows in panel B of the table. Correspondingly, earnings change multipliers differ across rows in panel A. The mean estimates of b_{1t} and b_{2t} in the last two columns of panel A again refer to equation (4): the dummy variable, D_{1it} is set at 1 if E_{it-1}/P_{it-1} falls in groups 2 or 4, and D_{2it} is set at 1 if E_{it-1}/P_{it-1} falls in groups 1 or 5, and zero otherwise. These estimates, although not significantly different from zero for some rows, indicate that controls for prior information are captured by E_{it-1}/P_{it-1}. Reading down the columns in panel A, one sees that earnings multipliers differ over Pr_{it} values for given levels of E_{it-1}/P_{it-1}. The Pr_{it} values reported concurrently with earnings do not just reflect the discounting of earnings by prior information, they also provide updated information on earnings valuation.[20]

V. Conclusion

The analysis shows that financial statements provide relevant information for the evaluation of earnings changes. Contemporaneous financial statement information indicates the persistence of earnings in the future, and leading financial statement information indicates the extent to which earnings have been anticipated. Both sets of information are relevant to the pricing of earnings changes in the sample. Further, earnings persistence in general is not a fixed characteristic of firms, but changes over time to become more like that of the typical firm. Correspondingly, earnings change multipliers are mean-reverting.

The reader may recognize a conflict between the results here and those in Ou and Penman (1989a). The results here indicate that the stock market recognizes *Pr* information and values earnings accordingly, while the Ou and Penman (1989a) study provides evidence of market inefficiency with respect to Pr. There is indeed an inconsistency. This is a disturbing problem with all research that examines contemporaneous associations between accounting numbers and stock returns. However, the inferences here do not require the market to be perfectly efficient. Ou (1990) reports that the market recognizes some of the *Pr* information when it is published, and this is true also of Ou and Penman (1989a, table 9). Similarly, Ou and Penman (1989b) show that *Pr* information is captured by contemporaneous E/P ratios (which, of course, reflect price). Thus the Ou and Penman (1989a) result can be interpreted as the market's being slow to capture all of the information in *Pr*.

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[19] The five groups are roughly E_{it-1}/P_{it-1} quintiles. The numbers of firms in groups are not exactly the same because groups were identified from a larger cross section than that which satisfied data requirements to estimate earnings change multipliers.

[20] Another potentially omitted variable is firm size. The results of Freeman (1987a) and Collins et al. (1987) suggest that earnings valuation measures estimated with returns over the 12-month period covered by the dependent variable in equation (2) vary over firm size. However, the positive correlation between *Pr* and firm size reported in Ou and Penman (1989a) is in the wrong direction to support this omitted-variable conjecture.

The findings here should be interpreted similarly to the classic Ball and Brown (1968) result. That result still indicates the information content of earnings even though "post-earnings drifts" in prices have been robustly documented. Note that the result in Ou and Penman (1989a) works against the inference here because the inefficiency is associated with the noncentral *Pr* values for which lower earnings multipliers are observed. If the market fails to recognize the *Pr* information for these levels of *Pr*, one would expect the estimated earnings multipliers to be higher, that is, closer to those for central *Pr* values.

The present study is helpful in developing a practical approach to the evaluation of earnings changes: it provides an *ex ante* indicator of earnings persistence and recognizes nonstationarity in persistence and the use of financial statement information to track the variation. Further research should seek more refined measures of persistence than the *Pr* instrument. This measure is based on one-year-ahead earnings changes only, and earnings persistence refers to earnings over a longer horizon. Because it is estimated from pooled data, it does not allow for variation in the relationship between financial statement items and future earnings over firms.

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SHORTER ARTICLES

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Non-Linearity and Specification Problems in Unexpected Earnings Response Regression Model

C. S. Agnes Cheng
William S. Hopwood
University of Houston
James C. McKeown
Pennsylvania State University

SYNOPSIS AND INTRODUCTION: In the last two decades of accounting research, many studies have investigated the relation between accounting variables and risk-adjusted security returns. The earliest studies (e.g., Ball and Brown 1968) used simple, nonparametric methods and focused mainly on the question of whether accounting earnings are associated with residual equity returns. Subsequent studies made methodological refinements in both the measurement and the statistical techniques. One important statistical refinement was the "unexpected earnings response regression model" (UERRM), a linear statistical model that uses the unexpected earnings variable as a regressor to explain risk-adjusted returns.[1] The UERRM has become well-known, and many recent studies (e.g., Cornell and Landsman 1989, 686; Daley et al. 1988, 580; Doran et al. 1988, 392; Landsman and Damodaran 1989, 107; McNichols 1989, 15) have used some form of it as a "benchmark" model, against which to compare more complicated models. In one paradigm (so popular that it has become almost standard practice), various accounting variables are added to the UERRM, and their "incremental information content" is assessed by testing the statistical significance of their coefficients. The inferences derived from this procedure are, of course, conditional on the degree to which the UERRM is correctly specified.

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[1] Thorough reviews of both the earlier and the later studies are given by Lev and Ohlson (1982) and Bernard (1989).

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A critical problem caused by using a misspecified UERRM is that its least squares estimator can lead to erroneous inferences in the research design. Despite the UERRM's popularity, researchers have expressed concerns regarding its specification. For example, Lev (1989) recently surveyed a large number of research papers that used some form of an UERRM and found that for the most part R^2s were low and often bordered on "the negligible." His table 1, which includes statistics from 19 studies, indicates that most reported R^2s are less than 10 percent. Although low R^2s are not proof of major specification problems, Lev does suggest that they are a cause for concern and may be the result of specification problems.

Investigation of multiple specification problems is an important aspect of the present study because the various specification issues are interrelated. For example, nonnormality can be associated with nonlinearity, which, in turn, can be associated with heteroscedasticity or variation in the coefficients (Judge et al. 1985, 455, 814, 839). Thus, *ad hoc* tests for a single specification problem can be misleading and can fail to identify the fundamental problems.

To our knowledge, no studies have comprehensively and formally evaluated the specification of the cross-sectional, ordinary least squares model that relates unexpected earnings to risk-adjusted security returns. Therefore, the purpose of this study is to test such a model systematically and empirically for specification problems. Specifically, this study tests for nonlinearity, heteroscedasticity, residual nonnormality, omitted variables, and interfirm systematic and random coefficient variation. Also, when appropriate, adjusted R^2-statistics are included to indicate the degree of misspecification—information that is not directly observable from the tests themselves. A high degree of generality is obtained by using three samples of earnings forecasts as proxies for expected earnings. These were obtained from IBES financial analyst consensus forecasts, *Value Line* financial analyst forecasts, and COMPUSTAT-based time-series forecasts. Daily and monthly security returns are considered for short and long event-windows, respectively. In addition, one study recently published in *The Accounting Review* (Cornell and Landsman 1989) is replicated. The findings from all of the samples and the replication indicate that the specification error is large enough to affect conclusions regarding economic relationships. For example, in the replication, the specification problems are shown to lead to substantial instability in inferences from the model.

Key Words: *Specification errors, Nonlinearity, Earnings response, Market-based accounting research.*

Data Availability: *Subject to legal restrictions, the data used for this study are available from the authors.*

THE remainder of this article is organized as follows: the next section presents a linear UERRM and its relation to the classical normal linear regression model (CNLRM). Section II sets forth statistical procedures for assessing specification violations, including tests for problems with nonlinearity, nonnormality of the residuals, omitted variables, heteroscedasticity, and random or systematic variation in the model parameters. The third section presents empirical results on security returns cumulated over short and long event-windows. Section IV reports the replication results, and the final section contains a summary and conclusions.

I. Analysis of the Specification of the UERRM

A specification analysis of the UERRM requires that the model be formally defined and that a statistical framework be selected. As noted (see also Bernard 1989; Lev and Ohlson 1982), one popular UERRM is the linear cross-sectional model that relates abnormal returns to unexpected earnings for firm *i* and period *t*:

$$CAR_{it} = a_t + b_t \cdot UE_{it} + e_{it}, \tag{1}$$

where:

$CAR_{it} \equiv$ cumulative risk-adjusted security return;
$UE_{it} \equiv$ unexpected earnings, scaled by market value;
$e_{it} \equiv$ disturbance term;
$a_t \equiv$ unknown intercept parameter; and
$b_t \equiv$ unknown slope parameter.

Throughout the remainder of this article, the term UERRM is defined by equation (1).[2] Our statistical framework is the commonly used CNLRM (see, e.g., Goldberger 1964; Kennedy 1979; Kmenta 1986), which when applicable, guarantees that the OLS estimator will be unbiased and efficient. In essence, this framework requires normal spherical disturbances (with expected values of zero), nonstochastic regressors, and a dependent variable that is a linear function of a specific set of regressor variables.[3] If the data meet the assumptions specified by the CNLRM, then the OLS estimator for *b* is unbiased and efficient within the class of unbiased estimators. Failure to meet any one or more of the assumptions, however, may render the OLS estimator biased, inconsistent, or inefficient.

Specification errors can be defined as violations of various assumptions of the CNLRM.[4] Although there are many ways to classify these assumptions, for the sake of convenience we use two general categories in the discussion that follows. These involve either the regressors (1 and 2 below) or the errors (3 and 4 below), as follows:

1. The dependent variable is a linear function of a specific set of independent variables plus an error term. This assumption can be violated in at least three ways:
    a. The wrong set of regressors is used (i.e., either relevant variables are omitted or irrelevant variables are included in the model).
    b. The model parameters are not fixed.
    c. The functional form is nonlinear.

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[2] This is the general form of the model. Details of computation of these variables will be given later in the paper.

[3] In the framework of the CNLRM, the assumptions are sufficient conditions for the OLS estimator to have all three properties of consistency, unbiasedness, and maximum efficiency. In alternative frameworks some of the assumptions of the CNLRM can be relaxed without serious consequences.

[4] The meaning of the term "specification error" varies in the econometric literature. Some restrict its meaning to only certain assumptions while others use it to mean the violation of any assumption. This study uses it in the latter sense.

2. The regressors are nonstochastic.
3. The error variance-covariance matrix is of the scalar identity form.
4. The errors are joint normal.

There is considerable reason to suspect that some of the basic assumptions of the UERRM, especially that of linearity, are untenable. Specifically, previous studies have shown that the earnings response coefficient varies with certain firm-specific characteristics, such as the discount rate, systematic risk, earnings persistence, size, and growth.[5] If the level of the unexpected earnings is related to any of these factors, then even if the true earnings-returns relationship is linear, the empirical cross-sectional UERRM will be nonlinear. Therefore, the assumption of linearity in the empirical cross-sectional UERRM requires a host of specific assumptions regarding orthogonality between unexpected earnings and various economic constructs.[6]

Intuitively, however, it seems unlikely that these assumptions of orthogonality are reasonable. First, it is well-known that the magnitude of earnings (as well as earnings variability) is correlated with systematic risk. For example, Foster (1986, 353) reports that the BARRA service uses earnings/price as a class of variables for β and return variance estimates. Second, it would seem that firms would find it relatively more difficult to sustain large increases in earnings than small ones. This would imply a correlation between unexpected earnings and earnings persistence. Third, it would seem that the level of earnings would vary with size, since size is associated with systematic risk, a determinant of expected earnings. Finally, Beaver et al. (1980) suggest that earnings growth (which is related to the level of earnings) is a determinant of the discount rate the market uses in capitalizing earnings.

II. Methods for Specification Testing

Figure 1 summarizes the statistical procedures used in this study to test for various violations of assumptions in the CNLRM. Each test is discussed below.

Box and Cox (1964) suggest a class of power transformations that generalizes the standard linear form. Unfortunately, this class is not defined for negative values of the untransformed variable, which poses problems for its use with the UERRM because variables on both sides of the UERRM equation take on negative values.[7] Therefore, the simple power transformation model was considered for equation (1):

$$CAR_{i,t}=a_t+b_t\omega|ue_{i,t}|^{\lambda}+e_{i,t}$$

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[5] Easton and Zmijewski (1989) use longitudinal models to conclude that beta is related to cross-sectional variation in the coefficient for unexpected earnings. Their longitudinal results imply that the earnings variable in cross-sectional estimation of equation (1) should be replaced by unexpected earnings plus the product of unexpected earnings times beta. This implication, of course, is conditional upon the absence of specification problems in their model as it is applied to equation (1). Overall, the model is better specified (e.g., it produces fewer specification errors and higher adjusted R^2s) with beta added as a linear term, so only those results are reported. Also since beta is used in the replication without resolving the stability problems, this means that specification problems in the UERRM are not removed by allowing for cross-sectional variation in the earnings response coefficient due to beta.

[6] A more detailed discussion of these assumptions, their importance, and reasons why the model might be misspecified can be found in Cheng et al. (1991). That paper also gives more detailed results of some of the analyses reported in this paper.

[7] The transformation can be computed by adding a constant to all realized values of the variables. But this approach then raises the problem of selecting an appropriate constant to add. Using the data for the present study and testing a wide range of addition constants, the severity of this problem is illustrated by λ estimates which are unstable or for which in many cases the nonlinear least squares would not even converge.

Figure 1

Statistical Tests for Assessing Violations of the Classical Normal Linear Least Squares Model

Possible Violation	*Tests for Violation*
Functional form and nonnormality of the residuals	Likelihood ratio test of power transformation parameter (nonlinearity). Ramsey (1969) regression specification (RESET) test (nonlinearity). Skewness and kurtosis tests (Barnett and Lewis 1978, 100–01) on the residuals (nonnormality and nonlinearity).
Omitted variables	Likelihood ratio tests for omitted variables.
Heteroscedasticity	BPG (Breusch and Pagan 1979; Judge et al. 1985, 445–47) and other tests.
Coefficients not fixed	g-test from Swamy's (1970) random-coefficient model to test a fixed-coefficients hypothesis. Slope-dummy test of the correlation between *b* and forecast error.

where $\omega=1$ if $UE \geq 0$ and $\omega=-1$ otherwise.[8] When $\lambda=1$, the standard linear model is produced as a special case, so that a test of $\lambda=1$ is a test of linearity.

The dependent variable was not transformed for two reasons. First, it would render the R^2-statistic noncomparable between models with different values of λ, thus making it difficult to assess the relative degree of specification error in one model vis-à-vis another. Second, the dependent variable is already based on a log transformation in the market model.

If the market does not assign the same multiplier to all values of the forecast error (perhaps because of a relatively low likelihood that extreme values will continue in the future), then estimates of λ should not be equal to 1.[9] An alternative test of linearity, Ramsey's (1969) regression specification test (RESET) is also used.

Normality of the residuals is tested by using sample skewness and kurtosis statistics (Barnett and Lewis 1978, 100–01). These statistics have the advantage of being resistant to the so-called masking effect, in which outliers distort the measures in favor of normality. Furthermore, they do not require that the variance be known, unlike the Kolmogorov-Smirnov statistic (Lilliefors 1967).

Diagnostic tests for omitted variables can be conducted by including possible omitted variables and evaluating the effect. Because previous research (see, Atiase 1980; Baldwin and Meyer 1979; Banz 1981; Easton and Zmijewski 1989; Kross 1985) suggests that size, price, and systematic risk may be omitted variables in the UERRM, we added these variables to the model and tested for increased explanatory power. Market value of the firm's common stock is used as a surrogate for size, market price per share of common stock is used to measure the price variable, and the slope coefficient from the log-form market model is used to measure systematic risk.[10] We use these variables for diagnostic purposes only and do not argue for their inclusion in practice.

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[8] The measurement and scaling of forecast error are discussed below. Note that a transformation parameter not equal to 1 logically implies omitted variables from the linear model. This can be seen by expanding (via Taylor Series) the right-hand side of the equation into linear plus other nonlinear terms. The nonlinear terms are the omitted variables. This provides an intuitive basis for the RESET test described below.

[9] The power transformation is a likely choice for researchers to test to solve the nonlinearity problem. It is included in the paper both to test linearity (i.e., is λ equal to 1?) and to inform researchers that there is fairly little benefit to using it instead of the simpler relative rank transformation, as is reported in the results section.

Heteroscedasticity can result from using a linear functional form to represent a nonlinear relationship, or it can occur as a result of simple variation in the magnitude of the observations. Since there are many ways that errors can systematically vary, there are many possible tests for heteroscedasticity. One such test is the Breusch-Pagan-Godfrey (BPG) test, in which the heteroscedastic relationship is based on a regression of the squared (normally distributed) residuals on selected regressors (Breusch and Pagan 1979; Judge et al. 1985, 445–47). Several other tests that produced similar conclusions were conducted, but only the BPG test is reported since it provided the best fit for the heteroscedastic relationship in our analyses.[11]

The standard UERRM assumes that the coefficients are fixed and the same for all firms. Alternatively, the coefficients might vary randomly or systematically across firms. If the coefficients come from a common distribution but vary randomly across firms, then some random-coefficient model, such as the Swamy model, is more appropriate than the fixed-coefficient model.[12] If the coefficients vary systematically across firms (as the results of Kormendi and Lipe 1987; Easton and Zmijewski 1989; Lipe 1990 suggest they do), then either a slope dummy-variable model or a seemingly unrelated regression model might be more appropriate (Judge et al. 1985, 550).[13]

III. Empirical Results

Three separate samples of earnings forecasts are used to measure specification problems. The first is based on time-series annual forecasts[14] for a COMPUSTAT sample (245 firms for 19 years), the second on IBES annual earnings forecasts (168–207 firms for 11 years), and the third on *Value Line* earnings forcasts (258 firms for five years). These data sources are described in Foster (1986, 80, 271, 277). All samples are limited to firms on the New York Stock Exchange that have December fiscal year-ends and meet normal requirements regarding data availability. The UERRM with long-window returns is investigated for all samples, and the UERRM with short-window returns is investigated for the *Value Line* and IBES samples.[15] The firms in the samples overlap, but the different forecast methods provide generality for the analysis.

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[10] A reviewer suggested that we use size-adjusted abnormal returns as the dependent variable to control for the size factor. We tested the "size model approach" described in Kothari and Wasley (1989) to generate the abnormal returns and found no major changes in results.

[11] As discussed above, a heteroscedasticity test must implicitly specify a model that relates the residuals and the regressors.

[12] The Swamy model assumes that the coefficients do not vary over time. If this assumption is not true, then some other model such as either the Hsiao or Hildreth Houck random coefficient might be appropriate (see Judge et al. 1985, 547, 806).

[13] Regardless of whether the coefficients vary randomly or systematically, the Swamy g-statistic (Swamy 1970) is useful in testing the null hypothesis that the coefficients are equal and fixed across firms. Therefore, this test and a slope-dummy analysis are performed.

[14] Since Albrecht et al. (1977) and Hopwood and McKeown (1981) find no evidence of superior forecasts from more sophisticated univariate time-series models, the random walk model is used for the time-series forecast for the COMPUSTAT sample.

All samples are quite homogeneous, with the largest amount of clustering in the utilities and chemical industries, which is comparable to the data base populations of other research studies. Given very similar results for the three samples, only IBES results are presented, with one exception. The COMPUSTAT results are reported for the random-coefficient analysis since the other samples lack sufficient data for estimation of longitudinal models.

Abnormal returns are computed from a standard market model on logged returns.[16] The model parameters are estimated for each firm for each year of the sample period during an estimation interval that includes 60 consecutive months ending in December of the year before the year of the earnings being announced. Abnormal returns are then computed for each month from January of the year preceding the announcement through the month of the announcement. The abnormal returns are standardized with Patell's (1976) method to minimize heteroscedasticity and are summed (after adjusting for the number of months in the period for each firm and earnings announcement) over the months in the event-window to form cumulative abnormal returns (*CARs*).[17] Identical procedures are used for short-window returns, with estimation extending from 160 to 61 days before the earnings announcement, and including both the day before and the day of the announcement.

The unexpected earnings are computed by subtracting the predicted from the reported annual earnings and dividing the difference by the market value of the firm's common stock on the day before the beginning of the event-window. The forecast closest to the beginning of the holdout period is used for each anlaysis.

Results for Long-Window Security

Specification Analysis of UERRM. Panel A of table 1 gives diagnostic statistics and associated specification tests for the single-regressor UERRM. Panel B presents specification diagnostics and tests for various alternative models described below.

As anticipated, panel A of table 1 shows that the earnings response coefficients are positive and significant (the third column). Furthermore, as reported in previous studies, many of the adjusted R^2-statistics are less than 10 percent. The BPG test of heteroscedasticity fails in four of the 11 years, which is considerably higher than would be expected by chance.

The R^2s associated with the Ramsey RESET test of linearity report the cumulative incremental explanatory power associated with adding the squared, cubed, and fourth powers of the fitted values of the dependent variable to the regression. For example, for

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[15] The short-event-window analysis was not applied to the COMPUSTAT-based annual time-series forecasts since one-year-ahead forecasts would be very much out of date at the beginning of a holdout period starting the day before the earnings announcement.

[16] The logarithmic form of the market model is used so the variable being analyzed equals the continuously compounded return. This also allows some appeal to a central limit theorem argument (Fama 1976, 20; Alexander and Francis 1986, 145) concerning normality.

[17] Unstandardized abnormal returns (UARs) yield results similar to those based on standardized prediction errors. The models with UARs have slightly higher R^2s, much more difficulty with heteroscedasticity (which is not fully correctable with GLS), and slightly higher incidence of specification errors in general. The heteroscedasticity problems are not surprising since the purpose of standardization is to correct for that problem.

Table 1
Diagnostic Evaluation of the Single-Regressor UERRM: $CAR = a + b \cdot UE$
(IBES Sample, Long Windows)

Panel A. Individual Years:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					Adj. RESET R^2s						
Year	*a*	*b*	*Adj* R^2	*BPG*	R^2_2	R^2_3	R^2_4	*Skew*	*Kurt*	λ	*F to Add Market Info*
75	.34†	6.64*	.024	.15	.018	.013	.030	.406	2.82	.94	22.11†
76	.09	3.87†	.041	.56	.060*	.158†	.164†	1.091*	5.09*	.41†	32.12†
77	.12*	8.54†	.159	6.04*	.190†	.187*	.231†	.929*	4.77*	.75*	23.84†
78	.28†	4.86†	.103	11.91†	.161†	.231†	.232†	.853*	4.70*	.28†	4.36†
79	−.55†	4.89†	.143	8.65†	.260†	.282†	.330†	.084	3.89	.45†	2.07
80	.39†	3.71†	.085	.92	.150†	.147†	.150†	.507*	3.05	.38†	6.09†
81	.44†	4.11†	.046	7.17†	.111†	.108†	.111†	.648*	2.81	.42†	55.16†
82	.50†	2.49†	.081	1.40	.147†	.161†	.168†	.296	3.12	.62†	49.91†
83	.07	1.49†	.027	.29	.031	.030	.040	1.203*	8.48*	1.54	5.86†
84	.01	3.17†	.142	2.42	.217†	.219†	.216†	.582*	4.71*	.52†	9.05†
85	.17*	1.73†	.114	.28	.110	.142*	.218†	.604*	3.87	.47†	13.85†

* Significant at alpha=0.05.
† Significant at alpha=0.01.

Panel B. Summary of All Years:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Number of Years with Rejections				*Adj RESET R^2s*			*No. of Sig.*	
Model	*BPG*	*BPGA*	*RESET*	*Adj.* R^2	R^2_2	R^2_3	R^2_4	*Skew*	*Kurt*
O—	4	2	8	.088	.132	.153	.172	8	5
E—	3	1	7	.141	.154	.178	.181	7	5
R—	2	0	6	.172	.201	.198	.201	7	5
OOOO	8	2	8	.250	.283	.296	.305	8	5
OLLO	6	2	6	.273	.298	.311	.320	7	5
ELLO	6	0	6	.307	.314	.326	.326	6	4
RLLO	6	1	4	.325	.333	.338	.341	6	4
ORRR	7	2	6	.274	.301	.312	.323	8	6
ERRR	6	0	6	.308	.317	.331	.333	7	5
RRRR	6	0	5	.325	.337	.344	.344	5	4

Model Codes:

Character Position

Character Position 1: Type of measurement for forecast error
Character Position 2: Type of measurement for price
Character Position 3: Type of measurement for value
Character Position 4: Type of measurement for beta

Type of Measurement

O: Original data, untransformed
E: Estimated power transformation parameter
R: Rank transformation
L: Log transformed

1985, the basic adjusted R^2 is 0.114. However, when all three powers of the fitted values of the dependent variable are added to the regression, the adjusted R^2 almost doubles to 0.218. Notice that in nine of the 11 years the fourth-power RESET test rejects linearity, providing convincing evidence against the simple linear functional form. Furthermore, the large increases in R^2 indicate that the degree of misspecification is considerable.

The skewness and kurtosis statistics for the residuals clearly indicate a pattern of nonnormality. For example, the skewness statistic rejects the test for normality in eight of the 11 years.

An additional test of linearity is the estimate of λ, the power transformation parameter, and a statistical test of the null hypothesis that the model is linear. When this parameter equals 1, the UERRM reduces to its standard linear form. Therefore, under the null hypothesis of linearity, the value of this coefficient should be 1. The data, however, strongly indicate that this is not true. The estimates are typically less than 0.50 and significantly different from 1 in nine of the 11 years.

The last column in panel A of table 1 displays a likelihood ratio test of the hypothesis that the market variables—price, market value, and beta—are omitted from the simple UERRM. The null hypothesis of no omitted variables is strongly rejected in virtually every year.

In summary, the statistics in panel A of table 1 provide considerable evidence of multiple specification problems in the simple UERRM. These problems include heteroscedasticity, nonlinearity, nonnormality of the residuals, and omitted variables.

Specification Analysis of Alternative Models. Because the simple UERRM fails most of the specification tests, several alternative specifications are considered for additional evidence on the specific causes of these failures and for possible improvement of the simple model. It should be emphasized, however, that we do not specifically advocate any of the alternative specifications set forth. The decision to use a given model in a particular research project needs to be made in light of numerous considerations, such as the sample size, the degree of misspecification for the particular sample and variables in the model, and the availability of theoretical alternatives for the particular research problem.

The additional models use alternative measures for all the variables—earnings forecast error, price, value, and beta. Also, generalized least squares (GLS) estimation is used when the BPG test fails.[18] Specifically, the measurement of each of the variables is considered according to various combinations of several possible transformations: transformation by estimating λ simultaneously with the other model parameters (E), transformation by the logarithmic function (L), no transformation (O), transformation by adding quadratic and cubic terms to the model, and transformation by ranking (R).

These specific transformations are selected according to the variable in question and the individual transformation's ability to correct specification problems. The E transformation allows powers of the regressor; therefore, it adjusts for nonlinearity. The rank transformation replaces the variable with the value of its rank and also generalizes the functional form since it is invariant under the entire class of order-preserving transformations, which include power transformations such as the square root as a special case. Furthermore, it is relatively insensitive to outliers. This transformation was suggested by Beaver et al. [1979] in their seminal work on the functional relationship between unexpected earnings and risk-adjusted returns. However, most subsequent studies have not used ranks.

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[18] For all models, we also consider the possible impact of outliers on the specification analyses. To do this, we reanalyze all models and samples with the largest 5 percent and the smallest 5 percent of the observations deleted. This procedure gives no material improvement in any model. This means that outliers may contribute to the specification problems, but removing them does not solve the problems.

In this research, ranks are standardized by the number of observations plus 1 $(N+1)$ so that the ranked variable has a maximum value of $N/(N+1)$ and a minimum value of $1/(N+1)$, with N being the number of observations. The standardization effectively produces coefficients with the desirable property of being independent of the number of observations. The terms "ranked" or "ranking" in this article refer to this relative rank procedure.

The logarithmic transformation is considered for the market-value variable since Brown et al. (1983) found this transformation useful in reducing skewness. The same transformation is also considered for the price variable. Finally, the polynomial transformation is considered since it defines a general functional form capable of capturing a wide range of nonlinearities.[19]

Panel B of table 1 presents specification diagnostics and tests for the various alternative models. With the characters E, L, O, and R used to indicate the types of transformations, as described above, each model is coded according to the placement of these letters in four character positions corresponding to (1) the transformation of forecast error, (2) price, (3) value, and (4) beta. A dash indicates that the given variable is not in the model. For example, model O— means that the forecast error is in original form (untransformed), and the other three variables are not in the model. In the RLLO model, the forecast error variable is ranked, price and value are logged, and beta is not transformed.

The second column in panel B indicates the number of years, out of 11 total, in which the BPG statistic rejects homoscedasticity at $\alpha=0.05$ for ordinary least squares (OLS) estimation. The third column is the same statistic but with generalized least squares (GLS) estimation used when the BPG test on OLS rejects homoscedasticity. For the number of years in which the quartic RESET test rejects linearity, each year's estimation is based on OLS if the related BPG test did not reject homoscedasticity; otherwise it is based on GLS. The adjusted R^2 is averaged across years, as are the RESET adjusted R^2-statistics based on adding the squared, cubed, and quartic powers, respectively, of the fitted value of the dependent variable to the OLS regression.[20] Panel B of table 1 also shows the number of years in which the skewness and kurtosis tests of the residuals reject normality. Again, these estimations are based on the use of GLS when the BPG test rejected homoscedasticity.

The O— model in panel B corresponds to the model reported year by year in panel A. For example, the BPG statistic is rejected for this model in four of the years (1977–79 and 1981), and this number corresponds to the entry for O— in the second column of panel B.

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[19] The polynomial model results are not reported in the tables to save space. They are qualitatively similar to the estimated transformation results.

[20] Although the regressions are based on GLS in the cases where the BPG failed for OLS, the R^2-statistics are computed from the OLS regression (which is conservative) since they lose their normal meaning with GLS regression.

The effect of nonlinearity can be assessed by comparing the R^2-values in panel B. For the simple, one-regressor, untransformed model (O—), adding the nonlinear squared, cubed, and quartic powers of the fitted dependent variable to the equation increases R^2 by approximately 100 percent (from 0.088 to 0.172). This implies that misspecification of the functional form causes, approximately, a 50 percent loss in explanatory power for the model. In contrast, this loss in explanatory power is much smaller for the RRRR model, averaging less than 10 percent. Although the incidence of RESET rejections is clearly non-zero for the RRRR model, the relatively small degree of loss in R^2 due to nonlinearity indicates that the problem is substantially mitigated.

The use of either the power or rank transformation of the forecast error variable produces a substantial improvement in R^2. This is shown by the adjusted R^2s for models E— and R—. These models yield adjusted R^2s of 0.141 and 0.172 compared to 0.088 for the untransformed model. Furthermore, simply adding the market variables (price, value, and beta) to the untransformed, single-regressor model (O—) causes the adjusted R^2 to almost triple. A substantial portion of this benefit remains even when the forecast error is transformed. Comparing the transformed, single-regressor models to any of the transformed, multiple-regressor models shows that the multiple-regressor models have considerably higher R^2s in all cases. For example, the best single-regressor model is R—, which has an R^2 of 0.172. This is considerably smaller than the R^2 of any of the multiple-regressor models and is clear evidence of omitted variables in the single-regressor model.

However, adding the market variables without transforming the forecast error does not produce the best model possible. Incorporating any of the transformations provides another substantial increase in R^2. In fact, the overall best model is RRRR, with adjusted R^2 of 0.325. This represents nearly a fourfold increase in explanatory power relative to the linear, single-regressor UERRM. Again, this large increase in R^2 indicates that the degree of misspecification in the linear, single-regression UERRM is considerable.

Although the problem of heteroscedasticity is pervasive, it is virtually eliminated when GLS is used as needed. This can be seen by comparing the results for BPG in panel B, table 1, which uses OLS, with those for BPGA, which used GLS. For BPG, the incidence of rejections is high and consistent across all samples. For BPGA, it is low and even zero for some models. This data strongly suggest a need to use GLS when the BPG test fails.

Finally, skewness and kurtosis of the residuals are problems for all models. Additional research is required to assess the specific cause (or causes) of these rejections, but possible sources may be anomalous observations or the distribution of the dependent variable, which is not subjected to additional transformations (other than the log transformation in the market model) to maintain comparability of R^2-statistics across models.

In summary, the statistics in table 1 are evidence of the increase in explanatory power (as a measure of the severity of specification problems) and the improvement in RESET and BPG tests when alternative models are used for the linear, single-regressor UERRM.

Results for Short-Event Windows

These results are similar to those for the long-windows except that the R^2-statistics are lower. In fact, the earnings coefficient is significant for only four of the 11 years for the O— model. This is no surprise since the event-window includes only the two days around the earnings announcement and does not incorporate information impounded in the market before that time.[21] Nevertheless, the earnings coefficient is significant for at least ten of the 11 years for any transformed model. In addition, the untransformed single-regressor model shows a very large loss due to nonlinearity (adjusted R^2 loss is from 0.034 to 0.009). As with the long event-windows, adding the market variables and transforming the variables produces the best overall models, and each of these procedures adds explanatory power. Furthermore, the RRRR model again substantially mitigates the nonlinearity problem, as can be seen from the relatively small loss in R^2 (from 0.050 to 0.047).

The skewness and kurtosis statistics are also similar to those for the long event-windows, and the number of rejections does not systematically depend on the choice of the model. Except for a smaller number of BPG failures (probably due to the lower R^2), the data indicate that all the specification problems considered exist for the short periods, and the alternative model specifications have the potential to either correct the specification problems or, at least, mitigate their impact.

Fixed-Coefficient Hypothesis

The relation between nonlinearity and systematic variation in the earnings forecast error coefficient is considered next. It should be emphasized that our interest in this issue is primarily as it pertains to the cross-sectional UERRM and nonlinearity; a thorough analysis of all sources in systematic variation in the coefficients of the longitudinal model is beyond the scope of this article.

Rejection of the overall null hypothesis that the coefficient is fixed implies that the coefficient varies across firms, but it does not indicate whether it varies randomly or systematically.[22] Therefore, we tested for systematic variation in the coefficient and specifically for correlation between the forecast error and the earnings response coefficient.

If there is no relation between the forecast error and the earnings response coefficient, the coefficient should be the same for all levels of forecast error in the cross-sectional regression. The sample is therefore partitioned into five groups on the basis of forecast error, and a likelihood ratio test is performed for the null hypothesis that the earnings response coefficient is the same for all five groups.[23] If the earnings response coefficient is unrelated to the size of the unexpected earnings, then the adjusted R^2 for the dummy-variable model should be no larger than that for the no-dummy-variable model.

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[21] The results of Thompson et al. (1988) suggest that the market reacts to news announcements other than earnings announcements. Therefore, for the IBES sample we attempt to reduce noise by eliminating firms that had significant news announcements relating in any way to the firms' earnings performance, including dividend announcements, within the 30 market days before the earnings announcement. Overall, this procedure does not yield any material improvement in the explanatory power of any model.

[22] The Swamy g-statistic (Swamy 1970) tests the null hypothesis that the earnings response coefficient is fixed. The alternative hypothesis includes both the case in which the coefficient comes from a random distribution (i.e., follows a Swamy Random Coefficient model; see Judge et al. 1985, 539) and the case in which it systematically varies with some exogenous variable. The g-test for the basic single-regressor O— model and the OLLO model rejects the fixed-coefficient hypothesis with an α error much less than 0.01. Rejection implies that the coefficient varies across firms, but it does not indicate whether it varies randomly or systematically.

[23] The number of groups is selected to provide for at least 30 observations in each group.

Table 2
Test for Correlation Between Forecast Error and Earnings Response Coefficient

	Long Windows				*Short Windows*	
	IBES		*COMPUSTAT*		*IBES*	
Model	R^2	R^2 *With Dummies*	R^2	R^2 *With Dummies*	R^2	R^2 *With Dummies*
O—	0.088	0.132 (8)	0.057	0.104 (12)	0.009	0.024 (4)
E—	0.141	0.171 (4)	0.120	0.172 (13)	0.027	0.031 (2)
R—	0.172	0.201 (4)	0.153	0.181 (9)	0.035	0.042 (2)
OLLO	0.273	0.298 (6)	0.229	0.262 (11)	0.022	0.031 (2)
ELLO	0.307	0.313 (1)	0.261	0.287 (9)	0.040	0.041 (0)
RLLO	0.325	0.337 (3)	0.299	0.312 (7)	0.047	0.050 (0)
ORRR	0.274	0.297 (6)	0.231	0.262 (11)	0.022	0.031 (3)
ERRR	0.308	0.317 (2)	0.265	0.293 (12)	0.040	0.041 (1)
RRRR	0.325	0.337 (3)	0.300	0.313 (7)	0.047	0.050 (0)

* The numbers in parentheses are the number of periods for which the R^2 with Dummies is significantly greater than the original R^2 out of 11, 19, and 11 possible periods, respectively.

Model Codes:

Character Position

Character Position 1: Type of measurement for forecast error
Character Position 2: Type of measurement for price
Character Position 3: Type of measurement for value
Character Position 4: Type of measurement for beta

Type of Measurement

O: Original data, untransformed
E: Estimated power transformation parameter
R: Rank transformation
L: Log transformed

The data in table 2 do indicate a higher R^2 for the dummy-variable version of the O— model. For example, for the COMPUSTAT sample, the likelihood ratio test rejects the null hypothesis of no correlation between forecast error and earnings response coefficient in 12 out of the 19 years, and the dummy model's average adjusted R^2 is approximately double that for the no-dummy model. This data therefore indicate that the coefficient varies systematically and that a pure random-coefficient model is inappropriate.

Next, the hypothesis that nonlinearity is associated with systematic variation in the earnings response coefficient is tested. Judge et al. (1985, 814) note that nonlinearity may cause coefficients of the model to appear to vary even when the true underlying structure does not change. (Of course, the cause might be that variation in the coefficients creates the appearance of nonlinearity.) We test for this possibility by investigating whether the transformations that control for nonlinearity remove or mitigate the systematic variation in the response coefficient. Inspection of the appropriate models, especially RRRR, reveals a substantial reduction of the systematic variation in the response coefficient. For example, for the RRRR model (short event-window, IBES sample), there are no rejections of the dummy-variable test at all, and the difference between the R^2s for the dummy-variable and no-dummy variable models (0.047 vs. 0.050) is very small. We therefore conclude that a portion of the systematic variation in the coefficient of the single-regressor UERRM is associated with the observed nonlinearity and the resulting specification error.

IV. Replication of a Recent Study

To assess the effect of specification errors on actual accounting research, we replicate a recent study by Cornell and Landsman (1989) that examines the influence of one-quarter-ahead earnings forecast revision, one-year-ahead earnings forecast revisions, and earnings forecast errors on *CAR*s. For the sake of brevity, we present results only for their tables 2 and 3, which account for their two main models[24] and their empirical findings. We do not provide details on the issues of their study, their sample, or the measurement of their variables. We follow their sampling plan and measure the variables exactly as described in their article.[25] Moreover, we use their notation so that the interested reader can refer to their article for detailed definitions and specifications relating to the meaning and measurement of the variables. It should be emphasized that we selected this study because it was recently published in *The Accounting Review* and we had the necessary data readily available. We do not address any issues in the study other than the problems potentially caused by misspecification of the UERRM.

Diagnostic evaluation of the two main models of Cornell and Landsman (each based on 4,146 observations from pooling of data for nine quarters) indicates problems with heteroscedasticity, nonlinearity, and nonnormality: for both the simple and full models the BPG, RESET, the skew, and kurtosis tests fail for the O— model. Using GLS removes the heteroscedasticity for both the simple and full models; further, the nonlinearity problem is removed for the full model, but the RESET test still fails for the simple model. These results must be interpreted in light of the extremely large sample of more than 4,000 observations, which implies very powerful tests that reject with very small effects. For example, in the RRRR application for the simple model, the adjusted R^2 and the RESET adjusted R^2-statistics are equal (0.075) with three digits of precision; nevertheless, the RESET test rejects for the difference between these two numbers, which is less than 0.001. This suggests that the loss in explanatory power attributable to nonlinearity is extremely small.

The diagnostic tests further show that using ranks substantially increases the explanatory power of the model from an adjusted R^2 of 0.006 for the untransformed simple model (O—) to 0.075 for the fully ranked model (RRRR). A similar increase occurs for the full model. In both cases, the adjusted R^2 increases from less than 1 percent to more than 7 percent.

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[24] The "Simple Model" relates AR_{it} on the left-hand side of the equation to three variables on the right-hand side of the equation: FE_{it} (the earnings forecast error for firm *i* and quarterly earnings announcement *t*), FRQ_{it} (the forecast revision for firm *i* for quarter $t+1$, made in response to the earnings announcement for quarter *t*), and FRY_{it} (the forecast revision for firm *i* for the next fiscal year). The "Full Model" also adds to the right-hand side DFE_{it}, $DFRQ_{it}$, and $DFRY_{it}$, which are indicator variables to permit the coefficients of *FE*, *FRQ*, and *FRY* to take on different values in the fourth quarter.

[25] Although we exactly repeated their sampling plan, our sample contains more firms than reported in the CL study. We discussed this with the authors and requested that they provide us with a list of the firms that they used. However, they were not able to give us the list. Our assumption is that the larger number of observations in the present study is a result of our using a more recent version of the IBES tape. In any case, this difference in sample should not affect our conclusions since these conclusions are based on comparisons of results within our own sample, not comparisons with CL's results from their sample.

To further assess the effects of specification error on the models of Cornell and Landsman, we examine the sensitivity of the coefficient estimates and their significance levels. We do this by randomly assigning half of the 4,146 observations to one partition and the other half to another partition. This gives us two large samples, each containing 2,073 observations. Next, all of the models are estimated separately for each of the two samples, and the stability of the estimates are compared across the two partitions. Given the large size of each sample, there should be considerable stability across the two partitions.

Table 3 presents the results for the two partitions, first for the original model with unranked forecast errors (panel A) and second for the model with ranked forecast errors (panel B). The results are striking. The significance or nonsignificance of the three slope coefficients in panel A differs across the two partitions in every instance. For example, the estimate of α_1 is 0.009 and not significant for the O— model in the first partition, panel A. In the second partition, the corresponding estimate is 0.016 and significant. In contrast, for the model with ranked forecast errors (panel B), the significance or nonsignificance of the three slope coefficients is consistent across the two partitions in every case but one, namely for α_2 in the RLLO model. Also note the substantially larger R^2s and t-values for α_1 and α_3 in panel B as compared to panel A. Moreover, not only are the t-values larger in panel B, they are more stable as well.[26]

Table 4 reports the stability analysis for Cornell and Landsman's full model. Again, the model with the ranked forecast errors (panel B) produces a considerably higher degree of stability in the estimates for the six slope coefficients. In the original model with unranked forecast errors (panel A), the significance or nonsignificance of each of the six slope coefficients differs across the two partitions for at least two of the three market forms. In contrast, for the model with the ranked forecast errors (panel B), significance or nonsignificance agrees in every case for all six slope coefficients except α_2. Again, the model with ranked forecast errors has considerably larger R^2s and larger t-values, especially for α_1, the coefficient for forecast error.[27] The overall results of the replication demonstrate that inferences from such applications of the UERRM are not reliable even in large-sample designs. In this case, a particular transformation (ranks) is successful in reducing the instability.

V. Summary and Conclusions

This research evaluates the specification of the commonly used unexpected earnings response regression model—a single-regressor model of the linear relation between earnings forecast error and cumulative risk-adjusted security returns. Three samples of earnings forecasts were obtained from IBES, *Value Line*, and COMPUSTAT (the latter sample was used to generate time-series forecasts). Returns for both short (two-day) and

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[26] The original model shows evidence of omitted variables since the explanatory power increases substantially when the market variables are added. Contrast this with the much smaller increase in explanatory power when the market variables are added to the model with ranked forecast errors.

[27] Table 3 and table 4 report results based on the first random partition set we ran. We repeated the procedure three additional times. The reported results fall about in the middle of the results obtained from these four trials. In one trial, some of the inferences of the unranked models are a bit more stable than the trial reported here, but in the other two trials, the inferences from the unranked models are less stable, even to the point where the same variable's coefficient is significant in opposite directions for the two partitions.

Table 3
Simple Cornell-Landsman Model Results for Two Partitions

$$AR_{it}=\alpha_0+\alpha_1 FE_{it}+\alpha_2 FRQ_{it}+\alpha_3 FRY_{it}+\epsilon_{it}$$

Panel A. Original Model With Unranked Forecast Errors:

Form of Market Terms	α_0	α_1	α_2	α_3	R^2
		Partition A			
None	−0.005*	0.009	0.196	0.020	0.002
(O—)	−2.819	1.814	1.633	0.424	
Logged	0.010*	0.033*	0.057	0.004	0.012
(OLLO)	2.522	2.324	0.309	0.093	
Ranked	0.004	0.032*	0.091	0.017	0.016
(ORRR)	0.992	2.292	0.459	0.340	
		Partition B			
None	−0.005*	0.016*	0.367*	0.119*	0.012
(O—)	−3.139	2.184	2.454	2.502	
Logged	0.013*	0.006	0.505*	0.097*	0.029
(OLLO)	3.875	0.921	3.342	2.564	
Ranked	0.005	0.008	0.432*	0.126*	0.033
(ORRR)	1.257	1.054	2.702	2.590	

Panel B. Model With Ranked Forecast Errors:

Form of Market Terms	α_0	α_1	α_2	α_3	R^2
		Partition A			
None	−0.042*	0.034*	0.003	0.036*	0.059
(R—)	−10.060	5.949	0.560	6.008	
Logged	−0.033*	0.034*	0.007	0.038*	0.064
(RLLO)	−3.422	6.044	1.246	6.598	
Ranked	−0.036*	0.034*	0.006	0.036*	0.066
(RRRR)	−6.415	5.964	1.202	6.261	
		Partition B			
None	−0.048*	0.045*	0.010	0.030*	0.073
(R—)	−11.840	7.635	1.635	4.851	
Logged	−0.038*	0.036*	0.011*	0.028*	0.081
(RLLO)	−4.209	6.251	2.101	4.846	
Ranked	−0.034*	0.035*	0.011	0.029*	0.084
(RRRR)	−6.168	6.123	1.959	5.015	

* Significant at $\alpha=0.05$ (two-tailed).

Table 4

Full Cornell-Landsman Model Results for Two Partitions

$$AR_{it}=\alpha_0+\alpha_1 FE_{it}+\alpha_2 FRQ_{it}+\alpha_3 FRY_{it}+\alpha_4 DFE_{it}+\alpha_5 DFRQ_{it}+\alpha_6 DFRY_{it}+\epsilon_{it}$$

Panel A. Original Model With Unranked Forecast Errors:

Form of Market Terms	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2
				Partition A				
None	−0.004*	0.023*	0.006	0.091	−0.018	1.288*	−0.321*	0.009
(O—)	−2.776	1.996	0.046	1.607	−1.465	3.816	−3.098	
Logged	0.010*	0.024*	0.039	0.083	−0.013	0.846*	−0.257*	0.020
(OLLO)	2.475	2.274	0.244	1.326	−0.864	2.030	−2.245	
Ranked	0.004	0.023*	0.035	0.128	−0.015	1.018*	−0.300*	0.024
(ORRR)	1.021	2.140	0.218	1.740	−1.032	2.435	−2.279	
				Partition B				
None	−0.005*	0.004	0.420*	0.122*	0.026	−1.182	−0.222	0.014
(O—)	−3.252	0.448	2.730	2.515	1.783	−1.814	−0.937	
Logged	0.013*	0.006	0.533*	0.086*	0.050*	−0.173	−0.483*	0.031
(OLLO)	3.881	0.718	3.544	2.433	3.300	−0.257	−2.324	
Ranked	0.005	0.005	0.475*	0.117*	0.042*	−0.295	−0.248	0.035
(ORRR)	1.269	0.475	2.848	2.431	2.459	−0.425	−1.035	

Panel B. Model With Ranked Forecast Errors:

Form of Market Terms	α_0	α_1	α_2	α_3	α_4	α_5	α_6	R^2
				Partition A				
None	−0.043*	0.038*	0.006	0.030*	−0.011	−0.018	0.042*	0.062
(R—)	−10.510	5.767	0.860	4.338	−0.902	−1.413	2.919	
Logged	−0.032*	0.036*	0.010	0.030*	−0.002	−0.019	0.038*	0.067
(RLLO)	−3.410	5.861	1.730	4.849	−0.154	−1.408	2.695	
Ranked	−0.036*	0.037*	0.009	0.028*	−0.006	−0.018	0.041*	0.069
(RRRR)	−6.493	5.907	1.638	4.445	−0.445	−1.376	2.876	
				Partition B				
None	−0.048*	0.047*	0.013*	0.023*	0.000	−0.023	0.034*	0.075
(R—)	−12.070	7.183	2.094	3.340	−0.003	−1.513	2.169	
Logged	−0.039*	0.039*	0.012*	0.021*	−0.015	−0.007	0.037*	0.085
(RLLO)	−4.296	6.245	2.039	3.257	−1.169	−0.537	2.408	
Ranked	−0.034*	0.039*	0.012*	0.022*	−0.012	−0.009	0.035*	0.087
(RRRR)	−6.294	6.209	2.022	3.378	−0.949	−0.664	2.299	

* Significant at $\alpha=0.05$ (two-tailed).

long (more than a year) event-windows were examined. In addition, the results of a recently published study were replicated.

The specification analysis includes tests for nonlinearity, heteroscedasticity, residual nonnormality, omitted variables, and coefficient variation across firms. The results are fairly consistent across all samples and event-windows: all the specification tests on the UERRM reject the CNLRM assumptions in almost all cases. One of the most pronounced effects observed is nonlinearity. For the single-regressor response model, the average adjusted R^2 indicates that the degree of misspecification is considerable, since adjusted R^2 typically doubles or triples when the regressor is transformed by one of several methods, including ranking, power transformation, and polynomial regression. This results casts serious doubt on the attempts to control for the effect of earnings in many studies of incremental information content. Further analyses indicate that nonlinearity, as well as omitted variables, is associated with systematic variation in the earnings coefficient.

A replication of a recent representative study (Cornell and Landsman 1989) indicates considerable instabilities in the estimates of the model coefficients. The degree of stability is assessed by dividing the sample of 4,146 observations into two partitions and randomly assigning half of the observations to one partition and the other half to the other. Both of Cornell and Landsman's main models are estimated for the two partitions, with 2,073 observations in each partition. The results are striking: for their first model, the inference regarding statistical significance ($\alpha=0.05$) does not agree even once across the two partitions. The results were only slightly better for their second model. However, with ranked forecast errors, this inconsistency in statistical significance is almost completely eliminated for their first model and is eliminated for their second model for five of the six coefficients.

In conclusion, severe specification problems exist in the simple regression of unexpected earnings response, and the replication shows that the effect of these problems can be substantive in an actual research study. The data indicate that the problems can be mitigated by various methods, including transformations (especially relative ranking), testing for heteroscedasticity and then using GLS when needed, and by controlling for the effects of value, price, and beta in the model.[28] It should be emphasized, however, that there are theoretical alternatives, especially longitudinal models (see, e.g., Collins and Kothari 1989), that might be superior to the standard cross-sectional linear model, with or without transformations, to mitigate specification problems. Any decision to use transformations should therefore consider data constraints, the particular research design, and available theoretical alternatives. More research on this issue is needed, and it is possible that the standard model might need to be completely abandoned.

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[28] The purpose of the regression must be considered in selecting a specification; for example, the relative rank transformation can be useful in tests of information content or incremental information content, but using ranks to test economic theories concerning the magnitudes of the coefficients may be inappropriate.

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Economic Consequences of SFAS No. 33—An Insider-Trading Perspective

Ramasamy Odaiyappa
University of New Orleans
S. M. Khalid Nainar
McMaster University

SYNOPSIS AND INTRODUCTION: The results of prior research on Statement of Financial Accounting Standards No. 33 (FASB 1979) and the effects of required disclosure of inflation have been mixed. Many studies report little or no information content for such disclosures (Beaver and Landsman 1983), although more recent studies (Bublitz et al. 1985; Lobo and Song 1989) report evidence of stock price reactions to releases of information on current cost. These studies were conducted at the aggregate level of the market and did not examine the trading behavior of particular classes of market agents. In contrast, this study focuses on the trading behavior of corporate insiders,[1] and, instead of the commonly used security returns, a non-price variable is the dependent variable of interest.

Managers (insiders) could have information about how disclosure might affect the value of a firm through political and contracting costs borne by the firm (Smith and Warner 1979; Holthausen 1981) well in advance of other traders (Jaffe 1974; Larcker et al. 1983). In conformance with their fixation on reported income and their general skepticism of market efficiency (Mayer-Sommer 1979), managers might perceive that investors would react negatively to the new information required by SFAS No. 33, especially when current-cost adjusted income falls below historical-cost income. As a consequence, they would be expected to sell their stocks in anticipation of a negative stock market reaction.

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[1] Company "insiders" include senior officers and directors who must report their sales and purchases of the firm's shares to the SEC.

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For a sample of 441 firms, this study investigates the relation between the initial release of inflation-adjusted information and the trading behavior of insiders. Specifically, it is hypothesized that the expectation that disclosure income will be lower than historical-cost income leads to net selling by managers prior to the initial disclosures under SFAS No. 33. The results are generally consistent with the hypothesis.

The analyses show results that are statistically significant (at conventional levels) for both the independent variables in this study—a proxy for income shrinkage and a proxy for earnings change in the expected direction. But one must keep in mind the limitations of inferences from analyses of insider-trading data (Larcker et al. 1983). Specifically, since there is no comprehensive theory of insider trading, it is difficult to interpret insider-trading activity, and the results of this study must be kept in perspective as additional evidence on the effect of SFAS No. 33 disclosures.

Key Words: *Insider trading, SFAS No. 33, Inflation accounting, Information content.*

Data Availability: *The data used in the study will be made available to interested readers for research purposes.*

THE remainder of the article is organized as follows: The research hypothesis is developed and stated in section I. The research method, encompassing sample selection and construction of the research variables, is described in section II. The results are presented and discussed in section III. In the fourth section, the major conclusions are restated, and some limitations of the analyses are noted.

I. Research Hypothesis

Prior studies concerning the information content of SFAS No. 33 were conducted at the aggregate level of the security market and did not examine the trading behavior of particular classes of market agents. The conflicting results of these studies could be attributed to the aggregation of expectations, both positive and negative, reflected in the stock price. Consequently, one might not find a significant directional price reaction in the aggregate and might infer that there is no new information in the accounting standard.

To overcome this shortcoming, we use insider-trading data. After analyzing insider-trading data to test for the information content of SFAS No. 19, Larcker et al. (1983, 608) observed that "if security market reaction analysis and insider trading results are consistent, a much stronger methodological basis exists for concluding that firms are affected by a mandated accounting standard." The focus here is on the trading behavior of company insiders who were privy to the potential effects of the initial information mandated by SFAS No. 33.[2] Prior research (Abdel-khalik and McKeown 1978;

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[2] It is possible that such behavior might be partially offset if managers' selling actions are construed as bad signals by investors at large, an action that might adversely affect the stock price. If managers are wealth-maximizers and their compensation is linked to firm value, they may eventually be adversely affected by their own ex ante net selling behavior. This effect is likely to be mitigated, as compensation plans based on accounting earnings are widespread, given the inability to observe total firm value (stock plus corporate debt) because much of corporate debt is not traded (Watts and Zimmerman 1986, 201–02).

Baesel and Stein 1979; Finnerty 1976a, 1976b; Jaffe 1974; Larcker et al. 1983; Odaiyappa 1985) supports the idea that insider trading may reflect information that is not yet publicly available.[3]

The objective of this study is to examine the association between the shrinkage[4] in the income disclosed according to SFAS No. 33, relative to historical-cost income and *net selling* by managers prior to the *initial* disclosures under SFAS No. 33. This study also examines insider trading associated with the initial release of replacement-cost information subsequent to ASR 190 (SEC 1976) because the same argument and hypothesis can be advanced about the partial replacement cost information that was made available through ASR 190.[5]

Specifically, the research hypothesis of this study, stated in its alternative form, is as follows:

> H1: Companies whose first disclosure under SFAS No. 33 shows a constant-dollar income that is relatively low compared to the historical-cost income experienced more than normal net insider selling (i.e., the higher the income shrinkage, the greater the net selling).

II. Research Method

Data Description and Sample Selection

Constant-dollar data were taken from the *Value Line Data Bank* Version III tape for SFAS No. 33. Historical-cost data were obtained from the COMPUSTAT tape. Data on insider trading were taken from the SEC's Ownership Reporting System tape distributed by the National Archives.

The sample firms in this study were selected from the SFAS No. 33 data bank. The initial sample of 1,350 firms satisfied the FASB criteria for reporting inflation-adjusted data. Other criteria that were imposed to facilitate empirical analysis reduced the sample to 441 firms for the year 1979. Table 1 lists these criteria and the number of firms that were removed through sequential application of the restrictions.

Measurement of Dependent and Independent Variables

The dependent variable of this study is insider-trading activity *per se* (and not price effects related to such activity) as measured by net selling (i.e., insiders' selling relative to their buying). Two measures are computed. One measure is the insider-trading selling ratio (*ITSR*):

$$ITSR_{it}=SS_{it}/[PS_{it}+SS_{it}], \tag{1a}$$

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[3] A necessary condition for trading by insiders to be successful is met, for it is well accepted that the stock market is not efficient in the strong form (Jaffe 1974). The important issue in the present context is the perception of stock market efficiency rather than its efficiency per se. Even if the market for managerial remuneration is competitive by way of ex post settling up (Fama 1980), it could be that the gain from insider trading may not be material from the point of view of the company and may be considered as part of managerial remuneration by stockholders.

[4] Measures of income shrinkage here are based on constant-dollar information because of data availability. Specifically, as noted later, the income shrinkage ratio is computed as the complement of the ratio of constant-dollar income from continuing operations to historical-cost income from continuing operations.

[5] This analysis is concerned with firms subject to SFAS No. 33 and not per se with those subject to ASR 190. In other words, data for the firms in our final sample (subject to SFAS No. 33) were collected in the years relevant for ASR 190. This distinction must be noted in evaluating the results pertaining to the ASR 190 analysis.

Table 1
Sample Selection Criteria (SSC) Listed in Order of Application

Category of Firms	*Number*
Total firms, SFAS No. 33 Data Bank Version III	1,350
Exclusion of financial firms and firms not giving details of constant-dollar-adjusted data	542
Total Remaining Firms	808
Less: Firms with negative historical-cost earnings	17
Firms in utility industry	137
Firms on which insider-trading information is not available	213
Total Sample Firms	441

Notes: Firms with negative historical-cost earnings were excluded to facilitate the definition of the earnings change (EC_i) variable.

Utility firms were excluded because their regulatory environment and other peculiarities render these firms different from others for financial-reporting purposes.

where:

PS_{it} = number of shares purchased by insiders of company i during period t; and
SS_{it} = number of shares sold by insiders of company i during period t.[6]

The other measure is net sales divided by shares outstanding ($NSSO$):

$$NSSO_{it}=[SS_{it}-PS_{it}]/SHO_i, \tag{1b}$$

where:

SHO_i = number of shares outstanding for company i.

Income Shrinkage Ratio (SR) *Variable.* This primary independent variable is defined as the complement of the ratio of constant-dollar income to historical-cost income and is represented as:

$$SR_i=1-[IFCOCD_i/IFCOHC_i], \tag{2}$$

where:

SR_i = shrinkage ratio for company i;
$IFCOCD_i$ = income from continuing operations on a constant-dollar basis for company i; and
$IFCOHC_i$ = income from continuing operations on a historical-cost basis for company i.

Higher values of SR_i imply greater income shrinkage. The primary test period relates to the year 1979 when the SFAS No. 33 supplementary information first became available. The FASB mandated that constant-dollar information be disclosed starting with the 1979 fiscal year, but current-cost-related disclosures were required only from the 1980 fiscal year. Constant-dollar information was available for most companies for the 1979 fiscal year while some firms voluntarily disclosed current-cost information as well. Hence, given non-availability of current-cost information, constant-dollar data were used to calculate the income shrinkage, SR_i.

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[6] The figures for insider transactions include both the open-market trades of existing shares and option transactions.

Earnings Change (EC) Variable. Insider trading can conceivably be affected by any and all private information about the firm. One summary measure in past studies has been the insider's presumed private knowledge of *historical* earnings expectations. Since unexpected earnings have been shown to be associated with insider trading (Abdel-khalik et al. 1984; Allen 1982; Penman 1982), earnings change is used in this study as an additional independent variable to control for insider trading beyond that in the variable of primary interest (the income shrinkage ratio). A surrogate for insiders' private knowledge of change in historical-cost earnings (*HC*) is measured as:

$$EC_{it} = [HC_{it} - HC_{it-1}]/HC_{it-1}, \tag{3}$$

where:

EC_{it} = earnings change for the *i*th firm in the *t*th period; and
HC_{it} = historical-cost earnings for the *i*th firm in *t*th period.

Companies with negative *HC* earnings in the denominator were eliminated because the variable is difficult to interpret in this instance.

Industry Membership Control Variable. Since the primary independent variable, SR_i, is likely to be affected by industry type, the following procedure was adopted. First, the industry average of the shrinkage ratio (*INDAVSR*) was calculated. Then the relevant industry average was subtracted from the shrinkage ratio of each firm in the industry to ascertain the relative position of the firm. Thus, the shrinkage ratio adjusted for membership in industry *j* is defined as:

$$ADJSR_{ij} = SR_{ij} - INDAVSR_j. \tag{4}$$

A similar adjustment for the industry effect on the earnings change variable (*EC*) yielded *ADJEC*, the industry-adjusted earnings change.

Table 2 shows the mean and standard deviation of the shrinkage ratio (*SR*) and earnings change ratio (*EC*) for various industries defined by a two-digit industry classification (Beaver and Landsman 1983). The average shrinkage ratio varies from −0.19 (for wholesale and retail trade) to 3.98 (for food, tobacco, and textiles). The average earnings change varies from 0.11 (for food, tobacco, and textiles) to 1.37 (for mining and construction).

Research Design

The events of primary interest are issuance of the exposure draft and publication of the first supplementary information by firms in accordance with SFAS No. 33. Additional analysis is done for the time of the first ASR 190 information release. The test periods immediately precede the events; specifically, the test periods in the study are:

- T1: July–December 1978 (six months preceding issuance of exposure draft).
- T2: July–December 1979 (six months preceding first information releases under SFAS No. 33).
- T3: July–December 1976 (six months preceding first information releases under ASR 190).

Table 2
Industry Statistics for the Shrinkage and Earnings Change Ratios

Two-Digit SIC Code	Industry Name	Number of Firms	Shrinkage Ratio Mean	Shrinkage Ratio Standard Deviation	Earnings Change Mean	Earnings Change Standard Deviation
10–17	Mining and construction	31	0.63	1.77	1.37	2.55
20–23	Food, tobacco, and textiles	45	3.98	23.77	0.11	0.30
24, 26	Lumber, paper, and allied products	21	0.19	0.21	0.37	0.41
28	Chemicals	49	0.15	0.47	0.22	0.25
29, 30	Petroleum and rubber	26	0.46	0.96	0.69	0.74
27, 31, 32, 38, 39	Other manufacturing	51	0.22	0.44	0.14	0.31
33, 34	Primary and fabricated metals	38	1.32	4.21	0.55	1.16
35, 36	Machinery	73	0.39	1.01	0.21	0.25
37	Transportation equipment	26	0.34	0.70	0.22	0.33
40–48	Transportation and communication	18	1.49	2.48	0.49	1.17
50–59	Wholesale and retail trades	63	−0.19	9.24	1.17	6.26

Control periods used for comparison with the test periods are as follows:

C1: The six-month period July–December 1975, which is three years before exposure draft was issued. This time period is also prior to ASR 190 and was chosen because the implementation of an earlier exposure draft in 1974 was stopped for 1975.

C2: The six-month period July–December 1981; by that time, inflation-adjusted data had been disclosed. At this point, the degree of income shrinkage for individual firms is common knowledge, and the novelty of this information would have been assimilated in the expectations of the market participants.

During the first control period, insiders' expectations based on private knowledge could not be related to the unknown income-shrinkage ratio. The second control period also satisfies this condition because, by that time, income shrinkage had become publicly known and was no longer private knowledge.

To test the hypothesis stated in section I, we compared net selling by insiders in the following test and control periods. (A time line of these periods is displayed in fig. 1.)

T1 and C1: Net insider selling just prior to the release of exposure draft (T1) compared with that three years earlier (C1).

T1 and C2: Net insider selling just prior to the release of exposure draft (T1) compared with that three years later (C2).

T2 and C1: Net insider selling just prior to publication of constant-dollar informa-

Figure 1
Time Line for Test and Control Periods

1975 July–Dec	1976 July–Dec	1977	1978 July–Dec	1979 July–Dec	1980	1981 July–Dec
C1	T3		T1	T2		C2

—— Test Periods
– – – Control Periods

Note:

T1: Period just prior to issuance of exposure draft;
T2: Period just prior to first information releases under SFAS No. 33;
T3: Period just prior to first information releases under ASR 190;
C1: Period three years prior to exposure draft;
C2: Period when inflation adjustments are no longer private knowledge.

tion under SFAS No. 33 (T2) compared with that four years earlier (C1).
T2 and C2: Net insider selling just prior to publication of constant-dollar information under SFAS No. 33 (T2) compared with that two years later (C2).
T3 and C1: Net insider selling just prior to the first information releases under ASR 190 (T3) compared with that of the previous year (C1).

The *difference* in the insider-trading ratios between the test (T) and control (C) periods is represented by the *NSSOD* variable, defined as follows.

$$NSSOD = NSSO(T) - NSSO(C), \tag{5}$$

(Recall that *NSSO* is net shares sold divided by shares outstanding; see equation [1b].)

Companies in the sample were rank-ordered by their *ADJSR* values (see eq. [4]). On that basis, two portfolios were formed, one (the top 40 percent) with high shrinkage ratios and the other (the bottom 40 percent) with low shrinkage ratios. The middle 20 percent of firms were omitted to reduce noise in the analysis. The statistics of primary interest are reported in table 3. The primary statistics on *NSSO* appear to show higher selling activity for firms with high shrinkage in all periods, including the control periods. This pattern is more consistent than the one exhibited by the *ITSR* breakdown. However, insider trading in T2 is consistent with the *ITSR* in T2, the only period when the ratio is higher for the high shrinkage firms.

The multivariate analyses involved the estimation of a multivariate regression model with the *ADJSR* and *ADJEC* variables and their interaction in continuous form as independent variables and with $NSSOD_{TC}$ as the dependent variable. The model parameters were determined as follows:

$$NSSOD^{i}_{TC} = \alpha_0 + \beta_1 ADJSR_i + \beta_2 ADJEC_i + \beta_3 \text{Interaction term} + \epsilon_i, \tag{6}$$

where $i = 1, \ldots, n$; $T =$ test periods 1,2,3; $C =$ control periods 1,2. The model includes an interaction term to capture the effect of the independent variables *ADJSR* and *ADJEC* on the dependent variable $NSSOD^{i}_{TC}$ according to the values of the independent variables. A plausible reason for this varying effect is that a combination of high shrinkage and negative earnings change affect the dependent variable quite differently from a combination of high shrinkage and positive earnings change.

Table 3
Primary Statistics of Insider Trading

	High Earnings Shrinkage				*Low Earnings Shrinkage*			
Period	*Purchases*	*Sales*	*ITSR*[a]	*Mean NSSO*[b]	*Purchases*	*Sales*	*ITSR*	*Mean NSSO*
July–Dec., 1978 (T1)								
Transactions	468	703	0.276	−0.007	433	785	0.451	−0.198
Shares in Millions	8.9	3.4			1.7	1.4		
July–Dec., 1979 (T2)								
Transactions	384	921	0.289	0.002	546	1,166	0.256	−0.445
Shares in Millions	10.6	4.3			8.7	3.0		
July–Dec., 1976 (T3)								
Transactions	472	1,203	0.367	0.021	605	1,221	0.389	−0.157
Shares in Millions	10.7	6.2			5.5	3.5		
July–Dec., 1975 (C1)								
Transactions	664	963	0.302	0.001	575	837	0.412	−0.135
Shares in Millions	6.7	2.9			5.7	4.0		
July–Dec., 1981 (C2)								
Transactions	899	782	0.380	0.100	712	807	0.420	−0.168
Shares in Millions	25.5	15.6			12.0	8.7		

[a] *ITSR* is the insider-trading selling ratio:

$$NSSO=\frac{Shares\ Sold-Shares\ Purchased}{Shares\ Outstanding}$$

[b] NSSO is net sales divided by shares outstanding:

$$ITSR=\frac{Shares\ Sold}{Shares\ Sold+Shares\ Purchased}$$

III. Results

Diagnostic checks of the estimated model with the difference in the insider-trading selling ratio (*ITSRD*) as the dependent variables revealed a heteroscedasticity problem. Also, the earnings change variable was not significant, possibly due to the nonalignment of the earnings change, and the insider-trading measure: the insider-trading measure *ITSR* was cumulated over a six-month period, but the earnings change was computed over one year. Consequently, to address the twin problems of misalignment and heteroscedasticity, the regression model was estimated and corrected for heteroscedasticity by using Wthies's (1980) procedure.[7]

The multivariate model was also estimated (table 4) by using the second measure of insider trading, NSSO (net sales divided by market shares outstanding), to test for the

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[7] The results for the model with *ITSRD* as the dependent variable to correct for the heteroscedasticity of unknown form (using the White t-test) and for the misalignment problem (by using an earnings forecast as of July, the starting point of our accumulation for the test period) are comparable to results presented in table 4. The test results of the shrinkage variable are in the expected direction and significant, but the result for the earnings change ratio is not significant.

Table 4

The Multivariate Model

$$NSSOD^{i}_{TC} = \alpha_0 + \beta_1 ADJSR_i + \beta_2 ADJEC_i + \beta_3 \text{Interaction} + \epsilon_i$$

	Adjusted R^2	Intercept		ADJSR		ADJEC		Interaction	
		Estimate	P>|t-Value|	Coefficient (t-value)	P>t-Value	Coefficient (t-value)	P>t-Value	Coefficient (t-value)	P>t-Value
$NSSOD_{11}$	0.75	0.03 (2.4)	0.01	0.07 (30.0)	0.01	0.02 (2.4)	0.01	0.06 (25.3)	0.01
$NSSOD_{12}$	0.03	−0.03 (−0.6)	0.52	0.03 (3.8)	0.01	0.00 (0.1)	0.90	0.03 (3.1)	0.01
$NSSOD_{21}$	0.77	0.17 (2.9)	0.01	0.36 (31.9)	0.01	0.13 (2.7)	0.01	0.35 (26.9)	0.01
$NSSOD_{22}$	0.66	0.11 (1.6)	0.10	0.32 (24.2)	0.01	0.11 (1.9)	0.05	0.31 (20.4)	0.01
$NSSOD_{31}$	0.44	0.02 (2.4)	0.01	0.02 (15.4)	0.01	0.01 (1.6)	0.11	0.02 (13.1)	0.01

Notes: The *t*-values in parentheses are White's (1980) values.

$$NSSOD_{TC} = NSSO(T) - NSSO(C)$$

where T = test period, *C* = control period, and NSSO = [net sales]/shares outstanding.

T1 = July–December 1978 (six months prior to issuance of exposure draft);
T2 = July–December 1979 (six months prior to release of information under SFAS No. 33);
T3 = July–December 1976 (six months prior to release of information under ASR 190);
C1 = July–December 1975 (three years prior to issuance of exposure draft); and
C2 = July–December 1981 (three years after issuance of exposure draft).

robustness of the results.[8] The significance of both the shrinkage and the earnings change variables at conventional levels is consistent with the hypothesis that insiders' trading on their own account in companies with income shrinkage was characterized by net selling of shares owned. The interaction term also appears significant for most of the tests. Estimates in table 4 also show a high level of adjusted R^2 in most of the regressions, which seems to indicate the good explanatory power of the model used in this study.

IV. Conclusions

This study examined the controversial issue of the effect of SFAS No. 33—mandated accounting disclosures for inflation. The results of earlier studies on this subject have been mixed. Many of the prior studies using security prices found little or no information content (e.g., Beaver and Landsman 1983), but more recent studies (e.g., Bublitz et al. 1985; Lobo and Song 1989) report that stock prices reacted to the release of the information. Using insider-trading data, this study finds evidence consistent with the hypothesis that insider trading was affected by SFAS No. 33.

However, we must remember the limitations of inferences based on insider-trading data (Larcker et al. 1983). Since there is no comprehensive theory of insider trading, it is difficult to interpret insider-trading activity, and the results of this study must be kept in perspective as additional evidence on the effect of inflation-adjusted disclosures under SFAS No. 33.

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[8] The model was checked for effects of outliers by using Cooke's *D*-statistic, and it was found that there was not much of a problem.

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Patterns in Unexpected Earnings as an Explanation for Post-Announcement Drift

Eli Bartov
University of Rochester

SYNOPSIS AND INTRODUCTION: This article presents an empirical exploration of a specific market-inefficiency explanation for the observed post-earnings-announcement drift in stock prices. The research question is whether or not the observed relation between unexpected earnings in quarter t and stock-price changes in quarter $t+1$ represents a failure of the market to characterize the time-series properties of earnings correctly.

The article contributes to the existing literature in two ways. First, it provides corroborating evidence of the failure of the market to characterize the properties of the process underlying earnings correctly. Second, and more importantly, it directly tests the conjecture that this failure explains the post-announcement drift.

Corroborating evidence of the market's failure to characterize the properties of the process underlying earnings correctly is derived from a distributed lag model; a LOGIT model is employed to regress unexpected earnings on their four most recent past realizations.[1] The results indicate that the probability of positive unexpected earnings in quarter $t+1$ is increasing in its (lagged) values for quarters t through $t-2$ and decreasing in its (lagged) value for quarter $t-3$.

The ability of the model to predict future earnings changes and stock

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[1] In conformance with the terminology of related research, the term "unexpected earnings" is used instead of "earnings changes." Underlying this approach is the assumption (empirically supported by several studies; see, e.g., Foster 1977) that a model of a seasonal random walk with a trend produces a reasonable proxy for market participants' earnings expectations. Notice the difference between "true" unexpected earnings (which reflect correct use of all available information) and unexpected earnings as defined here. True unexpected earnings are, by definition, serially uncorrelated, random variables with a mean of zero and, thus, are unpredictable, but unexpected earnings are predictable when they systematically differ from true unexpected earnings.

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returns outside of the estimation period was examined as well. The results show that the model robustly predicts both one-quarter-ahead earnings changes and future (abnormal) stock returns. Furthermore, future stock returns remain predictable even after current unexpected earnings are controlled. This last relation further corroborates the incremental explanatory power of the lagged unexpected earnings over the unexpected earnings of the current quarter with respect to the post-announcement drift in stock prices.

Although this predictability of future earnings changes and stock returns is consistent with the results of prior research (see, e.g., Foster 1977; Griffin 1977; Foster et al. 1984, table 1; Bernard and Thomas 1990, tables 1 and 5), there is an important difference between previous and present methodology. The tests here involve predicting future earnings changes and stock returns by using data from a holdout period, rather than by documenting correlations in the sample. Thus, the tests used here increase the confidence that the results are not driven by modeling or sampling errors.

Evidence from this study and prior research is consistent with the conjecture that the market systematically errs in predicting one-quarter-ahead (quarter $t+1$) earnings and stock prices. Such an error implies that a drift would be observed during quarter $t+1$, as the market uses predisclosure information to update expectations for earnings in quarter $t+1$. To my knowledge, the extent to which this error explains post-announcement drift has not been directly tested.

I formally test the extent to which this systematic error in predicting future earnings explains the drift by exploring the relation between the drift in stock prices observed in quarter $t+1$ and unexpected earnings in quarter t, while controlling for the implications of past earnings for future earnings. In particular, cumulative abnormal returns (*CAR*s) for the period commencing three days after the earnings announcements of quarter t and ending one day following earnings announcements for quarter $t+1$ were computed for four portfolios that were constructed on the basis of unexpected earnings in quarter t. Once the implications of past earnings for future earnings are controlled, the positive relation between unexpected earnings in quarter t and the drift in stock prices observed in quarter $t+1$ no longer exists. This finding suggests that the observed relation between unexpected earnings in quarter t and stock price changes in quarter $t+1$ is fully explained by a systematic error in forecasting earnings.

Key Words: *Post-announcement drift, Market inefficiency, Standardized unexpected earnings, Seasonal random walk.*

Data Availability: *Data can be obtained from sources identified in the article.*

THE remainder of this article is organized in four sections. The tests and results summarized above are discussed in detail in section III. Section I surveys the prior literature and explains the motivation for this study. Section II describes the sample selection procedure and the data, and section IV summarizes the main findings.

I. Background and Motivation

As early as three decades ago, Ball and Brown (1968) documented a systematic relation between current unexpected earnings and post-earnings-announcement changes in stock price. This relation implies that publicly available information can be used to predict abnormal stock returns, which is inconsistent with the maintained (semi-strong) efficient-market hypothesis.

Since Ball and Brown's pioneering study, an extensive effort to explain this anomaly has focused primarily on widely accepted market efficiency explanations.[2] Joy et al. (1977), Watts (1978), Foster et al. (1984), and Bernard and Thomas (1989), among others, have employed innovative approaches in investigating possible explanations for this post-earnings-announcement drift in stock prices; however, they have failed to provide a widely accepted market-efficiency explanation for this phenomenon.

More recently, the findings of several studies were consistent with a market-inefficiency explanation for the drift, suggesting that market participants fail to characterize correctly the process underlying earnings. Specifically, Bernard and Thomas (1989, table 5) and Freeman and Tse (1989) have shown that a relatively large percentage of the post-announcement drift for earnings of quarter t occurs after the earnings announcement for quarter $t+1$. Bernard and Thomas (1990) and Wiggins (1990) have shown that the unexpected earnings of quarter t can be used to predict the three-day stock price reactions to earnings announcements for quarters $t+1$ through $t+4$. Bernard and Thomas (1990) further showed that these predictable stock price reactions are associated with the autocorrelation structure of earnings. Finally, Mendenhall (1991) found that consecutive errors by analysts in forecasting a firm's earnings are positively correlated.

However, these studies have provided no direct evidence of the extent to which the failure to characterize correctly the process underlying earnings explains the drift. The primary objective of the current study is to test directly the following (market inefficiency) explanation for the observed post-announcment drift in stock prices: The observed relation between unexpected earnings in quarter t and stock price changes in quarter $t+1$ *fully* represents a failure of the market to characterize the time series properties of earnings correctly.

In addition to the findings of recent research, another reason for studying this particular explanation for post-annoucement drift follows from the market's well-known anticipation (in terms of stock price), of most of the information in reported income before the release of financial statements (see, e.g., Ball and Brown 1968). If market participants underreact to earnings announcements for quarter t because they fail to infer fully the implications of quarter t (and prior quarters') earnings for future earnings (quarter $t+1$), a drift would be observed during quarter $t+1$, as the market uses predisclosure information to update earnings expectations for quarter $t+1$.[3]

A third reason for studying this explanation of post-announcement drift is the potential for systematic errors in modeling and estimating the time-series properties of earnings. This is because of both the lack of a theory to predict the process that generates earnings and the complexity of the issues involved in empirically estimating stochastic processes in general.[4]

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[2] The following are three such explanations for post-announcement drift: (1) the capital asset pricing model (CAPM) is inadequate; (2) the parameter estimates of the CAPM are biased; (3) researchers assume information is available to the market before it is released publicly, the look-ahead bias.

[3] There is evidence that a number of sources provide predisclosure information on earnings. These sources include management's earnings forecasts (see, e.g., Lev and Penman 1990) and changes in a firm's financial policy (see, e.g., Bartov 1991).

II. Sample Selection and Description of the Variables

Sample Selection

The sample period is from January 1979 through March 1987 (33 quarters). The data for this investigation are drawn from three sources. Quarterly earnings per share (primary) excluding extraordinary items and discontinuing operations, adjustment factors (for stock dividends and stock splits), numbers of common shares outstanding, stock prices, and report dates of quarterly earnings per share are taken from the COMPUSTAT quarterly industrial file. The CRSP NYSE/AMEX daily returns file is the source for the daily stock returns, and the CRSP NYSE/AMEX daily index file is the source for the equally weighted market returns.

To be included in the sample, a firm-quarter observation must have the following data available on the COMPUSTAT file: 21 consecutive quarters of data for earnings per share and the adjustment factors, the report dates of quarterly earnings for the current and the next quarters, the number of shares outstanding at the beginning of the current quarter, and the stock price at the beginning of the current quarter. In addition, for tests involving stock returns, the required data for calculating cumulative abnormal returns (CARs) must be available on the CRSP NYSE/ASE daily returns file. To simplify calculations, firms with a non-December fiscal year-end excluded.

Description of the Variables

The tests involved calculations of standardized unexpected earnings (*SUE*) and CARs. Unexpected earnings of the *i*th firm in quarter t ($UE_{i,t}$) is the difference between actual and expected earnings for this firm-quarter observation. Expected earnings are generated by using a model of a seasonal random walk with a trend (SRWT), which is defined as follows:

$$Q_{i,t}=\delta_{i,t}+Q_{i,t-4}+\epsilon_{i,t}, \tag{1}$$

where $Q_{i,t}$ is quarterly earnings of the *i*th firm in period t. The $\delta_{i,t}$ parameter represents the trend and is estimated by using the most recent 20 quarters of data, beginning with quarter $t-21$ and going through quarter $t-1$ (this estimate is updated every quarter). $\epsilon_{i,t}$ is $Q_{i,t}$ residual.

Standardized unexpected earnings of the *i*th firm in quarter t ($SUE_{i,t}$) are defined as $UE_{i,t}$ deflated by the standard deviation of the forecast error of the SRWT model.[5] Two points should be noted. First, the earnings-expectations model in this study is designed to proxy for market expectations, not (in particular) to capture the "true" time series properties of earnings. The SRWT model is chosen because it is relatively simple to estimate (so market participants can use it), yet its accuracy in predicting future quarterly earnings is not much different from more sophisticated statistical models (see, e.g., Foster 1977).[6] Second, the definition of (standardized) unexpected earnings here conforms to its definition in prior studies in the area (see, e.g., Foster et al. 1984, 582).

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[4] Systematic errors by market participants in complex circumstances have been documented by prior studies. For example, Lakonishok and Vermaelen (1990) interpret their findings as suggesting that repurchase tender-offers create price uncertainty because of their complexity and, therefore, opportunities for mispricing.

[5] In estimating the standard deviation of the forecast error of the SRWT model, 20 quarters of data (i.e., 16 observations) were used, from quarter $t-21$ through quarter $t-1$. These estimates are updated every quarter.

Daily abnormal stock returns are computed by using the market model, as follows:

$$AR_{i,t,j}=r_{i,t,j}-a_i-b_i r_{m,t,j}, \tag{2}$$

where:

$AR_{i,t,j}$=the abnormal return for security i, from day $j-1$ to day j in quarter t,
$r_{i,t,j}$=the realized return for security i, from day $j-1$ to day j in quarter t,
$r_{m,t,j}$=the realized, equally weighted market returns from day $j-1$ to day j in quarter t, and
a_i, b_i=OLS estimates computed over the 100 trading days that end 310 days prior to the earnings announcement date for quarter t (a minimum of 30 observations was required).

The n-day cumulative abnormal returns of firm i in quarter t ($CAR_{i,T}$) are defined as follows:

$$CAR_{i,T}=\Sigma_T AR_i \qquad [T=(t,j_1),\ldots,(t,j_n)]. \tag{3}$$

III. Tests and Results

Test for the Autocorrelation Structure of Unexpected Earnings and the Predictability of Stock Returns

The results of previous studies point to the possibility that the earnings expectations of market participants do not fully reflect the implications of past earnings for future earnings. This implies that earnings changes will have effects that persist over time: unexpected earnings of a future quarter will be a function of lagged earnings changes. The relation betweeen one-quarter-ahead unexpected earnings and its four most recent lagged realizations is explored in this section.[7]

More formally, the following relations are estimated:

$$SUE_{i,t+1}=a_0+\Sigma_j a_j SUE_{i,t+1-j}+\epsilon_{i,t+1} \qquad (j=1,\ldots,4). \tag{4}$$

Equation (4) is estimated by a LOGIT model with *SUE* data polled across firms and over the sample period ending March 1986 (the remaining sample period, April 1986 through March 1987, is used to examine the outside-of-estimation-period predictions of the model).

Pooled data are used to bring more information to the estimation procedure. However, if the model parameters are firm-specific or unstable over time, this pooling procedure may reduce the ability of the model to predict one-quarter-ahead unexpected earnings (so the results that follow may be biased toward the null). The choice of the LOGIT procedure over more sophisticated models with continuous dependent variables (e.g.,

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[6] Foster also finds that, using the power to explain contemporaneous stock price changes as a criterion, there is little difference between the forecast errors from a seasonal random walk model and those generated by more accurate mechanical models.

[7] The lag length is consistent with findings of previous research (see, e.g., Bernard and Thomas 1990, table 1).

Table 1

Estimation of the LOGIT Model for Predicting Unexpected Earnings

	The Model: $SUE_{i,t+1} = a_0 + \Sigma_j a_j SUE_{i,t+1-j} + \epsilon_{i,t+1}$ $(j=1,\ldots,4)$					
Estimation Procedures	a_0	a_1	a_2	a_3	a_4	*Observations*
LOGIT	−0.186 (0.00)	0.649 (0.00)	0.313 (0.00)	0.074 (0.12)	−0.577 (0.00)	1,933

Note: $SUE_{i,t}$ is the standardized unexpected earnings (generated by a SRWT model) of the *i*th firm in quarter *t*. Dependent variable=1 if $SUE_{i,t+1} > 0.5$ (798 observations); 0 if $SUE_{i,t+1} < -0.5$ (1,135 observations). To reduce misclassifications, $|SUE_{i,t+1}| > 0.05$ is imposed. Also, to eliminate outliers, $|SUE_{i,t+1-j}| < 5$ $(j=1,\ldots,4)$ is applied. The observed significance levels for two-tailed tests are in parentheses. The LOGIT model uses *SUE* data pooled across firms and over the sample period ending March 1986.

OLS regression) represents a trade-off between robustness and efficiency. If correctly specified, models with continuous dependent variables yield stronger results. However, the LOGIT model appears more appropriate in the current context for two reasons. First, in predicting the sign of future earnings changes on the basis of the probabilities produced by the LOGIT model, the experience of prior research with LOGIT models (e.g., Ou and Penman 1989) can be used to determine the cutoff points for these probabilities. Second, accounting data that are pooled over firms and time often contain outliers. Outliers of the dependent variables tend to bias the estimates of OLS regressions but do not bias the estimates of LOGIT models.

Table 1 shows the coefficient estimates of the model along with their *p*-values. The estimates for the coefficients of unexpected earnings for the past three most recent quarters are positive (0.64, 0.31, and 0.07, respectively), and are highly significant at conventional levels (except for a_3, the coefficient of $SUE_{i,t-2}$, which is marginally significant). The estimate for the coefficient of standardized unexpected earnings at the fourth lag (a_4) is negative, −0.57, and highly significant.[8]

A similar autocorrelation structure in unexpected earnings (generated by a SRWT model) has been documented by previous studies (see, e.g., Foster et al. 1984, table 1; Bernard and Thomas 1990, table 1). However, what distinguishes the approach here is its ability to verify that these correlations are not (entirely) driven by estimation errors resulting from the mechanical generation of unexpected earnings. Rather, the correla-

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[8] To check the sensitivity of the LOGIT results, equation (4) was reestimated using an OLS regression. To reduce the likelihood that outliers of the dependent variable will bias the estimates, $|SUE_{i,t+1}| < 5$ was imposed. The following results were obtained:

$$SUE_{i,t+1} = -0.14 + 0.36 \bullet SUE_{i,t} + 0.20 \bullet SUE_{i,t-1} + 0.09 \bullet SUE_{i,t-2} - 0.42 \bullet SUE_{i,t-3}. \tag{4.1}$$

All estimates were statistically significant at the 1 percent level (two-tailed tests), and the adjusted R^2 was 26.35 percent. However, using cross-sectional data in a regression may result in downwardly biased *p*-values (due to positive cross-sectional correlations). To assess this possibility, the coefficients of equation 4.1 were reestimated using a two-step procedure. First, regression 4.1 was replicated for each fiscal quarter and year separately. Second, the means of the time series of coefficients obtained from the first step were tested. The results from this two-step procedure (available from the author upon request) were similar to the results reported above, which suggests that the significant results above do not represent understated *p*-values.

Table 2
The LOGIT Model's Performance in Predicting Unexpected Earnings in Quarter $t+1$

Portfolio	*Probability of Earnings Increase*	*Firm-Quarter Observation*	$SUE_{i,2+1}>0$	$SUE_{i,t+1}<0$	*% Correct Predictions*
1	>0.6	938	686	252	73.1
2	<0.4	1,118	402	716	64.0
Overall:		2,056	—	—	68.2

Note: $X^2(1)=282.9$; probability $[X^2(1)>10.83/X^2(1)=0]=0.0001$. The LOGIT model is described in the text; see equation (4). $SUE_{i,t+1}$ is the standardized unexpected earnings of the ith firm in quarter $t+1$. The analysis uses data from four quarters (April 1986 through March 1987) that lie outside the period used to estimate the model's parameters.

tions partially represent associations between one-period-ahead unexpected earnings and its past realizations. Verification is obtained by examining the ability of the model to predict future unexpected earnings and returns in a holdout period.

Specifically, firms were classified into two groups on the basis of the model predictions. One group consists of firms with a high probability (>0.6) of a one-quarter-ahead earnings increase; the other group contains firms with a low probability (<0.4) for such an increase. Note that probabilities close to 0.5 give little indication of the direction of a firm's earnings change in quarter $t+1$. Thus, firms with predicted probabilties between 0.6 and 0.4 were excluded from the sample when the predictive ability of the model was tested. Because there is no theory to provide guidance in determining these cutoff points, I used cutoff points from prior research (see, e.g., Ou and Penman 1989).

The results displayed in table 2 demonstrate that the model successfully predicts the sign of one-quarter-ahead unexpected earnings.[9] Overall, the model correctly predicts the direction of the change in one-quarter-ahead earnings 68.2 percent of the time. The X^2-statistic is highly significant ($X^2(1)=282.9$), further confirming that the model successfully distinguishes between firms that will exhibit a positive or negative earnings performance in the next quarter.

The model's ability to predict abnormal stock returns is examined next. If the implications of the past earnings for future earnings reflected in the LOGIT model will be learned in the future by market participants, then the model should predict stock returns. *CAR*s for the two portfolios described above were computed over the period commencing three days after earnings announcements for quarter t and ending one day following earnings announcements of quarter $t+1$.

Panel A of table 3 summarizes the performance of the model in predicting returns. The portfolio consisting of firms with high (low) predicted probabilities of positive unexpected earnings in quarter $t+1$ yields positive (negative) *CAR*s that are highly sig-

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[9] As mentioned, tests of the predictive ability of the model used data from the sample sub-period April 1986 through March 1987, which lies outside the period used to estimate the model's parameters. Avoiding overlap between these periods eliminates potential problems of statistical overfitting and increases the confidence that the results are not driven by modeling or sampling errors.

Table 3
Summary Statistics on the Cumulative Abnormal Returns of Portfolios Based on Predictions of Unexpected Earnings in Quarter $t+1$

Panel A. Probabilities Generated by the LOGIT Model for the Full Sample:

	Mean Predicted Probabilities	*Mean* $SUE_{i,t}$	*Mean* $CAR_{i,T+1}$	*Student t p-Value*
Portfolio 1 ($n=938$; $p>0.6$)	0.782	1.192	3.23%	0.000
Portfolio 2 ($n=1{,}118$; $p<0.4$)	0.215	−1.723	−3.21%	0.000

Panel B. LOGIT Probabilities that Contradict the Implications of the Unexpected Earnings in Quarter t:

	Mean Predicted Probabilities	*Mean* $SUE_{i,t}$	*Mean* $CAR_{i,T+1}$	*Student t p-Value*
Portfolio 3 ($n=157$; $p>0.6$)	0.747	−0.471	2.49%	0.050
Portfolio 4 ($n=208$; $p<0.4$)	0.235	0.426	−1.87%	0.076

Note: $SUE_{i,t}$ is the standardized unexpected earnings of the *i*th firm in quarter $t+1$; $CAR_{i,T+1}$ is the cumulative abnormal return of the *i*th firm over a period commencing three days after the release of earnings in quarter *t* and ending one day after announcements of earnings in quarter $t+1$. The student *t*-statistic tests the hypothesis that the mean $CAR_{i,T+1}$ is different from zero; p-values are the observed significance levels for one-tailed tests. All observations are drawn from four quarters outside the period used to estimate the LOGIT model's parameters.

nificant. Thus, the LOGIT model appears to capture value-relevant time-series dependencies in earnings changes yet to be reflected in stock prices.

Indeed, the predicted probabilities produced by the LOGIT model are not independent of unexpected earnings in quarter *t* ($SUE_{i,t}$). Specifically, panel A of table 3 shows that firms with high (low) predicted probabilities of positive unexpected earnings in quarter $t+1$ also exhibit positive (negative) unexpected earnings in quarter *t*. A rank correlation of the predicted probabilities produced by the LOGIT model with $SUE_{i,t}$ yields a highly significant Spearman coefficient of 0.73, which further confirms the positive association between these two variables. Thus, if there were no other information available, it would be difficult to determine which effect accounts for the results displayed in panel A of table 3. Is it implications of past earnings for future earnings (captured by the LOGIT model but yet to be appreciated by the market), or unexpected earnings of quarter t alone?[10]

This identification problem is addressed by repeating the test with only those observations that display a contradiction between the prediction of the LOGIT model and that implied by the unexpected earnings in quarter t. Thus, one portfolio contains firm-quarter observations with a high probability (>0.6) for an earnings increase in quarter $t+1$ but negative $SUE_{i,t}$; the other portfolio contains firm-quarter observations with a low probability (<0.4) for an earnings increase in quarter $t+1$ but a positive $SUE_{i,t}$.

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[10] If the unexpected earnings of quarter *t* alone account for the drift in stock price observed in quarter $t+1$, it may be that investors are slow to react fully to current earnings releases rather than that they fail to characterize correctly the time series properties of earnings. This has been argued in prior research (see, e.g., Joy et al. 1977, 222; Brown 1978, 27).

The results in panel B of table 3 demonstrate that, even after controlling for unexpected earnings in quarter t, the LOGIT model is still successful in predicting future returns. Portfolio 3, which contains firm-quarter observations with high probabilty of an earnings increase in quarter $t+1$ but a negative $SUE_{i,t}$, yields a positive mean $CAR_{i,T+1}$ (2.49 percent), which is significant at the 5 percent level (one-tailed test). Conversely, portfolio 4, which contains firm-quarter observations with a low probability of an earnings increase in quarter $t+1$ but a positive $SUE_{i,t}$, yields a negative mean $CAR_{i,T+1}$ (-1.87 percent), which is significant at the 10 percent level (one-tailed test).[11] As noted in the introduction, these results on the predictability of stock returns are consistent with those of Bernard and Thomas (1990, table 5). However, there is an important difference between their methodology and the methodology of this study. The tests here involve predicting future stock returns using data from a holdout period, rather than documenting correlations between stock returns around earnings announcements and lagged unexpected earnings. Thus, the tests used here increase the confidence that the results are not driven by modeling or sampling errors.

In summary, the results in tables 2 and 3 show that, on the basis of past earnings information, unexpected earnings and stock price changes in quarter $t+1$ are predictable. Furthermore, the results in panel B of table 3 show that the degree of predictability for stock-price changes exceeds the well-known correlation between the current quarter unexpected earnings and next quarter drift in stock prices; future stock returns remain predictable even after current unexpected earnings are controlled. These findings are consistent with the conjecture that market participants fail to characterize correctly the time-series process underlying earnings. Whether or not this failure explains the observed post-announcement drift in stock prices is explored in the next section.

Tests for the Post-Announcement Drift

Evidence presented in the previous section, as well as in prior research, is consistent with market participants erring systematically in predicting earnings in quarter $t+1$. Indeed, such an error implies that a drift would be observed during quarter $t+1$, as market participants use predisclosure information in quarter $t+1$ to update their earnings expectations. However, the extent to which this phenomenon explains the drift is unclear: Does it entirely explain the drift, or do other factors contribute to the drift as well? This question is explored by testing the relation between unexpected earnings in quarter t and the drift in stock prices observed in quarter $t+1$, after controlling for the implications of past earnings for future earnings. If the relation between unexpected earnings in quarter t and the drift in stock price changes in quarter $t+1$ fully represents a systematic misperception of the time-series process underlying earnings, this relation should no longer exist once this misperception is controlled.

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[11] The effects of unexpected earnings in quarter t and of the implications of past earnings for future earnings yet to be appreciated by the market (measured by the LOGIT model) on *CAR*s in quarter $t+1$ were further investigated by regressing the *CAR*s on these two variables. The results (not reported) appear to suggest that, once the LOGIT model's measure is controlled for, the association between current unexpected earnings and future *CAR*s no longer exists. However, these results should be interpreted with caution because the regression's two explanatory variables are highly collinear.

Table 4
Summary Statistics on CARs for Non-Randomized and Pseudo-Randomized Portfolios Formed on Unexpected Earnings

Panel A. Non-Randomized Portfolios Formed on the Basis of SUE in Quarter t:

Unexpected Earnings Portfolio	*Observations*	*Mean Predicted Probabilities*	*Mean* $SUE_{i,t}$	*Mean* $CAR_{i,T+1}$	*Student t p-Value*
1	514	0.18	−3.61	−2.77%	0.000
2	514	0.37	−0.45	−2.67	0.001
3	514	0.54	0.32	1.26	0.074
4	514	0.79	2.16	3.09	0.006

Panel B. Pseudo-Randomized Portfolios Controlling for Differences in Predicted Probabilities for Positive SUE in Quarter t+1:

Unexpected Earnings Portfolio	*Observations*	*Mean Predicted Probabilities*	*Mean* $SUE_{i,t}$	*Mean* $CAR_{i,T+1}$	*Student t p-Value*
1	513	0.40	−3.17	−0.28%	0.866
2	515	0.47	−0.40	−0.05	0.973
3	515	0.50	0.31	−0.45	0.824
4	513	0.52	1.68	−0.29	0.866

Note: $SUE_{i,t}$ is standardized unexpected earnings (generated by a SRWT model) of the *i*th firm in quarter *t*. $CAR_{i,T+1}$ is the cumulative abnormal return of the *i*th firm computed over a period commencing three days subsequent to earnings releases for quarter *t* and ending one day following earnings announcements for quarter $t+1$. Student *t*-statistics are tests of the hypothesis that the mean $CAR_{i,T+1}$ is different from zero; p-values are the observed significance levels for one-tailed tests. The analysis covers the period April 1986 through March 1987 (four quarters), which is outside the sample period used to estimate the parameters of the LOGIT model described in the text.

The test technique is as follows. Initially, firm-quarter observations were assigned to one of two groups on the basis of their predicted probabilities for positive unexpected earnings in quarter $t+1$. The cutoff points were <0.4 and >0.6, as before. Next, observations within each group were ranked in descending order on the basis of their *SUE* in quarter *t*. Finally, quartiles from the *SUE* distribution of each group were used to assign observations to one of four portfolios of *SUE* in quarter *t*. Thus, portfolio 1 contains observations from the lowest quartile of *SUE* in quarter *t* in each of the two groups, and portfolio 4 contains observations belonging to the highest quartile in each of these two groups. Note that, by construction, the inter-portfolio differences in terms of *SUE* in quarter *t* are likely to be significant. In contrast, the four portfolios are expected to be quite similar in terms of predicted probabilities for positive unexpected earnings in quarter $t+1$.

Before discussing the results for this test, it is important to examine the relation of quarter *t* unexpected earnings in the sample and the corresponding abnormal returns during the following quarter. The results presented in panel A of table 4 are consistent with prior research findings and indicate that grouping observations into portfolios on the basis of unexpected earnings in quarter *t* identifies a systematic relation between current unexpected earnings and future stock price changes. Portfolio 1, consisting of firms in the lowest quartile of unexpected earnings in quarter *t*, experienced significantly negative *CAR*s (−2.77 percent) in the period commencing three days after earnings announcements for quarter *t* and ending one day after earnings announcements for quarter $t+1$. In contrast, portfolio 4, consisting of firms from the highest quartile, experienced significantly positive *CAR*s (3.09 percent) in that same period. These results provide a benchmark for evaluating the returns of the portfolios after controlling for inter-portfolio differences in the implications of past earnings for future earnings.

Panel B of table 4 shows the mean predicted probabilities for positive *SUE* in quarter $t+1$, mean *SUE* in quarter *t*, and mean *CAR*—computed over a period commencing three days subsequent to quarter *t* earnings releases and ending one day following earnings announcements for quarter $t+1$—together with its *p*-value, for four portfolios constructed on the basis of *SUE* in quarter *t* while pseudo-randomizing (not perfectly) over predicted probabilities for a positive *SUE* in quarter $t+1$. Reading across panel B, note that the test technique was successful in constructing four portfolios that are noticeably different in terms of *SUE* for quarter *t* and quite similar with respect to the LOGIT model's predicted probabilities. The *SUE* means for portfolios 1 through 4 range from −3.17 to +1.68. In contrast, variation in the LOGIT model's predicted probabilities appears markedly smaller; for each portfolio the mean predicted probability is not much different from 0.5.

As for the returns performance of the portfolios in panel B, the systematic relation between unexpected earnings in quarter *t* and future returns apparent in panel A no longer exists. The *CAR*s on the four portfolios in panel B are relatively small and not significantly different from zero at conventional levels. Thus, taken together, the results in table 4 suggest that the observed relation between unexpected earnings in quarter *t* and stock-price changes in quarter $t+1$ represents a misperception of the time-series process underlying earnings.

Moreover, the results presented in table 4 are inconsistent with the alternative explanation that the drift reflects lengthy (rather than instantaneous) adjustments of stock prices to current quarter earnings releases (see, e.g., Joy et al. 1977, 222; Brown 1978, 27). Since the inter-portfolio variations with respect to unexpected earnings in quarter *t* are similar in panels A and B of table 4, the conjecture of a lengthy adjustment implies a similar drift in both panels. However, the drift shows up in panel A but not in panel B.[12]

Finally, the differences between the results reported here and those of related research appear noteworthy. Related research (see, e.g., Freeman and Tse 1989; Rendleman et al. 1987) has shown that most of the drift associated with unexpected earnings in quarter *t* is eliminated after controlling for the unexpected earnings of quarter $t+1$. However, to control for unexpected earnings in quarter $t+1$, studies used the actual reported earnings for quarter $t+1$, thereby using information unavailable to the market in quarter *t*. Consequently, their results are a variant of the well-known Ball and Brown (1968) result and, in particular, do not allow for inferences to be made about the relation between the drift and inefficiency of earnings forecasting. In contrast, the current study controls for unexpected earnings in quarter $t+1$ by using only information that was available to the market in quarter t. This technique allows inferences about the relation between the observed post-announcement drift and the future implications of past earnings information yet to be appreciated by the market.

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[12] Note that, given the extensive coverage of quarterly earnings disclosures by the media and the degree of sophistication exhibited by market participants in other situations (see, e.g., Bartov 1991), it appears somewhat implausible that market participants are as inefficient as implied by this conjecture of prior research.

IV. Conclusion

This article is an empirical exploration of a specific market-inefficiency explanation of observed post-announcement drift in stock prices: Does the observed relation between unexpected earnings in quarter t and stock-price changes in quarter $t+1$ represent a failure of the market to characterize the time-series properties of earnings correctly? The findings support the failure of the market to characterize the process underlying earnings correctly and suggest that this failure fully explains post-announcement drift.

The evidence involved a relation between one-quarter-ahead unexpected earnings and its four most recent lagged values, which was estimated empirically with a LOGIT model. The results indicate that the probability of obtaining positive unexpected earnings in quarter $t+1$ is increasing in its (lagged) values for quarters t through $t-2$ and decreasing in its (lagged) value for quarter $t-3$.

In addition, the ability of the model to predict earnings changes and returns was examined in a holdout period. The results indicate that the model robustly predicts both one-quarter-ahead earnings changes and future (abnormal) stock returns. Furthermore, future stock returns remain predictable even after current unexpected earnings are controlled. This last relation further reinforces the conjecture that lagged unexpected earnings have incremental power in explaining the next quarter drift in stock prices, above and beyond the explanatory power of the current unexpected earnings. Although these results on the predictability of future earnings changes and stock returns are consistent with the results of prior studies, there is an important difference in methodology. The tests here involve predicting future earnings changes and stock returns by using data from a holdout period rather than by documenting correlations in the sample. Thus, these tests increase the confidence that the results are not driven by modeling or sampling errors.

The evidence on the link between the market's failure to characterize correctly the process underlying earnings and the post-announcement drift involved a test that examined the relation between the drift in stock prices observed in quarter $t+1$ and unexpected earnings in quarter t, after controlling for implications of past earnings for future earnings. The result indicates that the positive relation between unexpected earnings in quarter t and the drift in stock prices observed in quarter $t+1$ no longer exists once the implications of past earnings for future earnings are controlled.

These findings could be interpreted as an instance in which market participants, relying on predisclosure information, anticipate, in terms of stock prices, most of the information contained in reported income for quarter $t+1$ prior to its actual release (see, e.g., Ball and Brown 1968). However, this predisclosure earnings information for quarter $t+1$ systematically relates to lagged earnings realizations and therefore could have been anticipated at the time earnings for quarter t were released, had the market correctly characterized the stochastic process that generates earnings.

This explanation appears acceptable in light of the complex issues involved with estimating the time-series properties of earnings, and seems consistent with the approach of other recent studies. For example, Lakonishok and Vermaelen (1990) argue that repurchase tender-offers create price uncertainty because of their complexity and, therefore, more opportunities for mispricing. Still, the lack of capital asset pricing theories for informationally inefficient markets to explain such phenomena as the drift leaves room for skepticism. Furthermore, it is puzzling that, although so many years have gone by since the post-announcement drift was first documented by Ball and Brown (1968), arbitrageurs still have not fully traded on this phenomenon and thereby eliminated it.

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COMMENTS

Refined Conditions for Fully Revealing Income Disclosure

Don Vickrey
The University of Tulsa

SYNOPSIS AND INTRODUCTION: Demski and Sappington (1990) treat income disclosure as a process that conveys fully revealing information, and they establish two results related to this commentary: (1) an income-disclosure procedure is fully revealing if, and only if, the related end-of-period, present-value measures always are invertible in the realized information-structure signals, and (2) strict favorableness is sufficient for fully revealing income disclosure under the true probability measure.

This commentary shows that the first result follows from a more interesting necessary and sufficient condition than invertibility. Essentially it shows that an income-disclosure procedure is fully revealing if, and only if, differences in perceptions about the discounted expected values of future cash flows or differences in current cash flows are possible in all periods for all cash flow/signal pairs. In the context of the second result, an alternative, more general, sufficient condition for fully revealing income disclosure under the true probability measure is identified. This outcome is assured if differences in perceptions about the discounted expected values of future-periods' cash flows are possible in all periods for all cash flow/signal pairs.

Key Words: *Accounting theory, Income, Information.*

DEMSKI and Sappington (1990) construe income disclosure as a process that conveys fully revealing information.[1] The valuation concept they adopt is present value, $V_t(\bullet)$, and their method of calculating income, $I_t(\bullet)$, is equivalent to ex post economic income under uncertainty.[2] Their research establishes two results (propositions 2 and 3) that are relevant here. First, an income disclosure procedure,

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[1] Their work is related to that of Ohlson (1987)—who argues that the income-measurement perspective should not be abandoned, but reconciled with the information-economics perspective (as suggested in Beaver and Demski 1979).

[2] Economic income can be calculated in both *ex ante* and *ex post* senses (e.g., Edwards and Bell 1961; Revsine 1973; Beaver 1981).

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$I \equiv \{I_t\}_{t=0}^{T}$, which is consistent with probability $p \in P$, is fully revealing if, and only if, $V_t(h_t;d,p)$ is invertible in $y_t \forall h_{t-1} \in H_{t-1}$, $x_t \forall t=0,\ldots,T$. Further, strict favorableness (SF) is sufficient for full revelation under π (where h_t= the firm's accounting history through t, d= the discount rate ≥ 1, p= the general probability structure, x_t= the period t net cash flow, and π= the true probability measure).

In section I of this comment, a refined necessary and sufficient condition for fully revealing income disclosure is derived in the Demski and Sappington framework. It shows that an income-disclosure procedure, $I \equiv \{I_t\}_{t=0}^{T}$, which is consistent with probability $p \in P$, is fully revealing $\forall h_{t-1} \in H_{t-1}$, $x_t \forall t=0,\ldots,T$ if, and only if, for each $t=0,\ldots,T$, either (1) expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ or cash-flow differences of the form $x_{t'} \neq x_{t''}$ are present or (2) the procedure is weakly transparent in y_t. Expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ are explained immediately below, and "weak transparency" is defined subsequently. Section I also identifies a sufficient condition for fully revealing income disclosure under π that is similar to, but subsumes, SF. It indicates that expectational differences of the form mentioned above are sufficient. Section II provides implications for future research.

I. The Refined Conditions

In Demski and Sappington, income is the sum of the period's net cash flow and change in expected present value:

$$I_t(h_t;d,p) \equiv x_t + V_t(h_t;d,p) - V_{t-1}(h_{t-1};d,p). \tag{1}$$

From equation (1) and the Demski and Sappington valuation procedure,

$$I_t(h_t;d,p) = x_t + V_{t+1}(h_t;d,p)d^{-1} - V_{t-1}(h_{t-1};d,p).^{3} \tag{2}$$

Values of the form $V_{t+1}(h_t;d,p)$ are denoted below as $V_{t+1}(\bullet)'$ or $V_{t+1}(\bullet)''$ for arbitrarily selected (possible) cash flow/signal pairs $(x_{t'}, y_{t'})$ and $(x_{t''}, y_{t''})$. They are referred to, for example, as expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$. Such differences are related to differing perceptions about the discounted expected values of future cash flows arising from the possible y_t.

The substance of Demski and Sappington's proposition 2, ignoring cases of weak transparency (discussed below), subsists in the invertibility of $V_t(h_t;d,p)$ in y_t for a given t. Here, their result is based on a one-to-one mapping of period-t cash flow/signal pairs into possible end-of-period t present values of the form $V_t(h_t;d,p)$. Such a mapping is possible if, and only if, all potential values of this form are unique in t. Thus, a necessary and sufficient condition for the uniqueness of these values in t is also necessary and sufficient for the invertibility of $V_t(h_t;d,p)$ in y_t.

Note that an income-disclosure procedure obviously is fully revealing in t if x_t conveys the same information as $y_t \forall y=1,\ldots,Y$ (Y= the number of possible signals). With η_t informative, this condition holds if, and only if, there is a one-to-one mapping of signals into cash flows in t (which implies that the period-t cash flows are unique in t). In this context, an income-disclosure procedure that is fully revealing in period t because of a one-to-one mapping of signals into cash flows is defined here as strongly

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[3] $V_t(h_t;d,p)$ is the time t present value of the $t+1$ expected present value of future cash flows and, thus, $V_{t+1}(h_t;d,p)$ is discounted only one period in arriving at $V_t(h_t;d,p)$. Also, $V_{t+1}(h_t;d,p)$ is a function of the specific signal $(y_t \in h_t)$ received at t. Thus, $V_{t+1}(h_t;d,p)d^{-1}$ can be written as $V_{t+1}(h_t;d,p,y_t)d^{-1}$.

transparent in y_t.[4] Also, such a procedure is trivially fully revealing in period t if η_t is null because the null structure, η_t^0, yields one (or no) signal. An income-disclosure procedure that is fully revealing in t because η_t is null is defined here as weakly transparent in y_t.

As indicated, a necessary and sufficient condition for the uniqueness of values of the form $V_t(h_t;d,p)$ in t is also necessary and sufficient for the invertibility of $V_t(h_t;d,p)$ in y_t (ignoring cases of weak transparency). Such a condition exists and is related to expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ and realized cash flows differences of the form $x_{t'} \neq x_{t''}$ for arbitrarily selected cash flow/signal pairs, $(x_{t'}, y_{t'})$ and $(x_{t''}, y_{t''})$. In this context, equation (2) implies $V_t(h_t;d,p) = I_t(h_t;d,p) - x_t + V_{t-1}(h_{t-1};d,p)$.

Now consider two arbitrarily selected pairs, $(x_{t'}, y_{t'})$ and $(x_{t''}, y_{t''})$, generated by $\gamma_t(s)$ and $\eta_t(s)$. From here, two possible values of $V_t(h_t;d,p)$ for period t are: (1) $V_t(h_t;d,p)' = I_t(h_t;d,p)' - x_{t'} + V_{t-1}(h_{t-1};d,p)$ and (2) $V_t(h_t;d,p)'' = I_t(h_t;d,p)'' - x_{t''} + V_{t-1}(h_{t-1};d,p)$. Since $V_{t-1}(h_{t-1};d,p)$ is the same in each case, $V_t(h_t;d,p)' - V_t(h_t;d,p)'' = [I_t(h_t;d,p)' - x_{t'}] - [I_t(h_t;d,p)'' - x_{t''}]$. If $I_t(h_t;d,p)' = I_t(h_t;d,p)''$ initially, $V_t(h_t;d,p)' - V_t(h_t;d,p)'' = x_{t''} - x_{t'}$. Given this assumption, $x_{t'} \neq x_{t''}$ is necessary and sufficient for both $V_t(h_t;d,p)' \neq V_t(h_t;d,p)''$ and $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$. Thus, expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ or cash-flow differences of the form $x_{t'} \neq x_{t''}$ are necessary and sufficient for the uniqueness of the values of the form $V_t(h_t;d,p)$ and, therefore, for fully revealing income disclosure in t, given $I_t(h_t;d,p)' = I_t(h_t;d,p)''$. Note, however, that the values of the form $V_t(h_t;d,p)$ are not unique under the assumption that $I_t(h_t;d,p)' = I_t(h_t;d,p)''$ and $x_{t'} = x_{t''}$. Thus, an income-disclosure procedure is not fully revealing if $I_t(h_t;d,p)' = I_t(h_t;d,p)''$ and $x_{t'} = x_{t''}$.

Now suppose $I_t(h_t;d,p)' \neq I_t(h_t;d,p)''$. Then, equation (2) implies $I_t(h_t;d,p)' - I_t(h_t;d,p)'' \neq 0 = (x_{t'} - x_{t''}) + [V_t(h_t;d,p)' - V_t(h_t;d,p)'']$. Thus, $V_t(h_t;d,p)' - V_t(h_t;d,p)'' \neq 0$ and $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ when $x_{t'} - x_{t''} = 0$ and $I_t(h_t;d,p)' \neq I_t(h_t;d,p)''$. It follows that expectational differences of this form are necessary and sufficient for the uniqueness of the values of the form $V_t(h_t;d,p)$ and, thus, for fully revealing income disclosure in period t given $I_t(h_t;d,p)' \neq I_t(h_t;d,p)''$ and $x_{t'} = x_{t''}$.

Note that such expectational differences are only sufficient for the uniqueness of the values of the form $V_t(h_t;d,p)$ and, thus, for fully revealing income disclosure in t given $I_t(h_t;d,p)' \neq I_t(h_t;d,p)''$ and $x_{t'} \neq x_{t''}$. That is, these differences could fail to be necessary and sufficient under these assumptions only if $V_t(h_t;d,p)' - V_{t-1}(h_{t-1};d,p)$ equals $V_t(h_t;d,p)'' - V_{t-1}(h_{t-1};d,p)$. This result can occur under these assumptions if, and only if, $V_{t+1}(\bullet)' = V_{t+1}(\bullet)''$ under both $(x_{t'}, y_{t'})$ and $(x_{t''}, y_{t''})$. $V_{t+1}(\bullet)'$ may or may not equal $V_{t+1}(\bullet)''$ under these conditions. Thus, expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ are sufficient, but not necessary, for the uniqueness of the values of the form $V_t(h_t;d,p)$ and, therefore, for fully revealing income disclosure in t, given $I_t(h_t;d,p)' \neq I_t(h_t;d,p)''$ and $x_{t'} \neq x_{t''}$. However, in such cases, $x_{t'} \neq x_{t''}$ by assumption. Thus, similar to the prior case, expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$

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[4] Demski and Sappington are confusing on the issue of an income-disclosure procedure being fully revealing in t if x_t conveys the same information as $y_t \forall y = 1, \ldots, Y$. Although they appear to acknowledge that such a procedure is fully revealing in this context, this point is not covered clearly in their proposition 2, etc. This proposition probably should refer to the invertibility of $V_t(h_t;d,p)$ or x_t in y_t. This comment explicitly covers the possiblity of an income-disclosure procedure being fully revealing when x_t conveys the same information as y_t.

or cash-flow differences of the form $x_{t'} \neq x_{t''}$ are necessary and sufficient for the uniqueness of the values of the form $V_t(h_t;d,p)$ and therefore, for fully revealing income disclosure in t, given $I_t(h_t;d,p)' \neq I_t(h_t;d,p)''$. Since $x_{t'} \neq x_{t''}$ is necessary for an income-disclosure procedure to be strongly transparent in y_t, this concept does not have to be dealt with explicitly in the above analysis.

In summary, if weak transparency in y_t fails to hold, the above analysis implies that an income-disclosure procedure, $I \equiv \{I_t\}_{t=0}^{T}$, which is consistent with probability $p \in P$, is fully revealing in period t if, and only if, expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ or cash-flow differences of the form $x_{t'} \neq x_{t''}$ are present. Ultimately, this analysis implies that an income-disclosure procedure, $I \equiv \{I_t\}_{t=0}^{T}$, which is consistent with probability $p \in P$, is fully revealing $\forall h_{t-1} \in H_{t-1}$, $x_t \forall t=0,\ldots,T$ if, and only if, for each $t=0,\ldots,T$, either (1) expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ or cash-flow differences of the form $x_{t'} \neq x_{t''}$ are present or (2) the procedure is weakly transparent in y_t.[5]

Since $p \equiv \pi$ is irrelevant above, the analysis implies an alternative sufficient condition for fully revealing income disclosure under π—the existence of expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ $\forall h_{t-1} \in H_{t-1}$, $x_t \forall t=0,\ldots,T$. This condition is similar to SF since both are associated with expectational differences, but it subsumes SF since it is necessary for the expectational differences existing under SF. Significantly, fully revealing income disclosure exists under this condition in all cases in which (1) $I_t(h_t;d,p)' = I_t(h_t;d,p)''$ and the income-disclosure procedure is not weakly transparent in y_t and (2) $I_t(h_t;d,p)' \neq I_t(h_t;d,p)''$. These conclusions follow directly from the above analysis (see fn. 5).

II. Implications for Future Research

The primary result of this analysis is the identification of the refined neceassary and sufficient condition for fully revealing income disclosure. This condition is more interesting than invertibility since it clearly reveals the significant sources of fully revealing income disclosure. Also, it connects naturally with the concepts of *ex ante* and *ex post* information usage and content (see Demski 1974; Beaver and Demski 1979).[6]

Consistent with the prior literature (e.g., Demski 1974), this analysis implies that the *ex ante* and *ex post* roles of information often are interlaced in the fully revealing income-disclosure setting of Demski and Sappington (see fn. 5). It also implies that economic income values (i.e., accrual accounting analogs) alone, as well as net cash-flow figures alone, can serve both functions in this setting in a fully revealing fashion. Nevertheless, the accrual and cash-flow procedures have different *ex ante* and *ex post* potentials in this context. These differing potentials have possible significance empirically since, for one thing, cash-flow data typically are disclosed subsequently to accrual data. In addition, there are differential costs inherent in reporting cash-flow data, accrual data, and both. These observations suggest several avenues for future research, including the identification of: (1) the necessary and sufficient conditions for income-disclosure procedures to be fully revealing in the ex *post* sense, (2) the conditions under which the ex *post* and ex *ante* functions of information always are intertwined, and (3) the cases in which ex *post* economic income is superior to net cash flow in providing information for both ex *ante* and ex *post* information usage (and vice versa).

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[5] A longer version of this comment, which elaborates on these and points made later (partially through examples), is available from the author.

[6] Information has *ex ante* information content and is relevant in *ex ante* probability revision if it is used in revising expectations about future states. Thus, *ex ante* information content is linked naturally with expectational differences of the form $V_{t+1}(\bullet)' \neq V_{t+1}(\bullet)''$ in Demski and Sappington. Information has *ex post* information content and is relevant in *ex post* state revelation if it is pertinent in determining the realized state of the world and, thus, e.g., the realized net cash flow for the period (which also can be construed as being consistent with Bayes' theorem). Thus, *ex post* information content is linked naturally with cash-flow differences of the form $x_{t'} \neq x_{t''}$ in Demski and Sappington. They deal explicitly only with *ex ante* information content and usage, even though fully revealing income-disclosure procedures also can be construed as pertinent in the context of *ex post* information content and usage.

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Further Thoughts on Fully Revealing Income Measurement

Joel S. Demski
Yale University
David E. M. Sappington
University of Florida

IN Demski and Sappington (1990), we reconcile a potential schism between the view that accounting systems disclose information and the view that they measure income. Income measurement entails reporting in each time period (1) present-period cash flows and (2) an accrual measure based on these cash flows and the change in the expected present values of future cash flows. Information disclosure is ensured if one can always identify which of the possible events in a given event structure has occurred in each time period.

The central question in Demski and Sappington (1990) is whether the income measurement or valuation language of accounting systems constrains their ability to convey information. Stated differently, the question is whether it is possible to rescale the information so that it takes on the form and substance of an accrual calculation. More formally, the question is whether information disclosure can be ensured by an income measurement procedure. Proposition 2 in our study provides a necessary and sufficient condition. The invertibility condition in the proposition requires a one-to-one relationship between possible events and income reports in each time period. In particular, for any history of events and current-period cash flow realization, the continuation expected present value must be distinct for each possible current-period information event realization.

Vickrey (1992) presents a corollary of our proposition 2, providing an interpretation of the critical invertibility condition that involves expectational differences. Conceivably, the interpretation may be "more interesting," as Vickrey suggests. Technically, expectational differences are constructed by moving forward in time the end-of-period valuation operator. Thus, a direct rescaling of the continuation expected present value operator in our proposition 2 is undertaken, This leads to a statement about the necessity of expectational differences that is logically equivalent to the invertibility condition in Demski and Sappington (1990): holding history and current period cash flow constant, the continuation expected present value must differ for different information events if information disclosure is to be ensured.

Vickrey also introduces the concept of "weak transparency," referring to the special case of a null information structure. Under the null information structure, there

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is a constant mapping from underlying states of nature to the set of reported events (or the possible messages to be conveyed). There is essentially no information to be conveyed by income measurement when the information structure is null, so the invertibility condition is satisfied trivially.

The main implication of the "possibility result" in Demski and Sappington (1990) is that the ability of an accounting system to convey information is not constrained by a requirement that it value assets or measure income. The argument is not (as Vickrey suggests in his opening line) one that treats "income disclosure as a process which conveys fully revealing information." Rather, the argument is that use of a measurement process focused on income measurement is not a constraining medium for conveying an arbitrary, exogenous information structure. Although the formal analysis in our 1990 study focuses on the simple case where the information to be conveyed is unidimensional, the argument is more general. Vector-valued information can readily be conveyed by a vector-value income report, even one that entails the seeming arbitrariness often associated with cost allocation.

Our possibility result suggests that one must look elsewhere to discover institutional features of accounting systems that constrain their ability to convey information. It also suggests that having identified meaningful constraints on an accounting system, one must be cautious in interpreting the information content of accounting reports. This caution is emphasized in Antle et al. (1992). Antle et al. model an accounting entity that conveys periodic reports with an income measurement perspective. The entity operates in an informationally efficient market where all information that is relevant for valuation (including the accounting report) is processed rationally by the market. A key element of the model is that the accounting report does not attempt to reflect all relevant information. Data such as order books and macroeconomic statistics are relevant for valuation and can be observed directly by the market, but in practice they are not usually reflected explicitly in accounting systems. This leads to the issue of restricted recognition rules.

In Antle et al., both the accounting apparatus and the valuation algorithm employed by the market are expected value calculations. Consequently, the accounting series has the same properties as the market series, given the restriction on the information allowed into the accounting system. Knowing the properties of both series allows an examination of their statistical properties, which in turn permits an investigation of what precisely is conveyed by an accounting system and how it is conveyed. When a market series and an accounting series convey different information, it is important to capture the statistical interaction between the two series in empirical studies. Otherwise, interpretation of observed empirical phenomena can be problematic.

In Antle et al., the information conveyed by the accounting system and the information not conveyed by the accounting system are specified exogenously. An issue that warrants additional research concerns the type of information that is best reflected in formal accounting reports and the type that is better transmitted via alternative media. Vickrey appears to touch on this issue (in fn. 6) when he distinguishes between *ex post* and *ex ante* functions of information. In our view, though, the central question concerns the comparative advantage of a particular information channel, rather than whether the information assigned to a particular channel can be rescaled to take on the form and substance of the accountant's art.

Future research might also expand existing analyses of the equilibrium supply of information in a market setting where information is costly to acquire, and where repeated (or continuous) market interactions occur. It would then be possible to examine the efficient timing of information release in the presence of multiple sources of information. Investigations along these and related lines strike us as the most interesting extensions of the exploration in Demski and Sappington (1990).

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BOOK REVIEWS

Shane R. Moriarity, Editor

Editor's Note: Two copies of books for review should be sent to Professor Shane R. Moriarity, School of Accounting, University of Oklahoma, Norman, OK 73019. The policy of the *Review* is to publish only those reviews solicited by the Book Review Editor. Unsolicited reviews will not be accepted.

PETER BAIDA, *Poor Richard's Legacy: American Business Values from Benjamin Franklin to Michael Milken* (New York: William Morrow and Company, Inc., 1991, pp. 360, $11.00, paper).

Poor Richard's Legacy is a brief introductory history of business thinking in America from colonial times to the present. For serious scholars of business history it offers little that is either controversial or new. Virtually all that Baida has to say can be found in greater detail in any of several books on American business history. This book contains relatively standard profiles of business giants such as Rockefeller, Vanderbilt, Astor, Morgan, and Carnegie to which he adds the warnings of dissenting voices such as Thoreau, Twain, Galbraith, Sinclair Lewis, and Ralph Nader. This mix of contrasting personalities highlight the interaction between the economic forces of American business and the popular literature.

Who should read *Poor Richard's Legacy*? Anyone who is interested in American business history. The book is light, well-written and traces the changes in business values from the industry, frugality, and prudence of Franklin to the debt, looking out for number one, and bottom line mentality that permeates American business thought of today. Baida is careful not to sermonize about the spiraling decline of American business values. He doesn't have to; the havoc wrought by the demise of the junk bond market and Union Carbide's Bhopal disaster adequately highlight the problems in American business.

The book starts with Baida, a Wharton School of Business graduate student, dreaming about Ben Franklin, the stern taskmaster, wrestling with the fun-loving Huck Finn for his soul. This serves as the springboard for an introduction to the value system that epitomized Ben Franklin. Without making direct comparisons between any of the profiled individuals, Baida documents the changes in American business thinking. He concludes the book with all the individuals attending a grand party. At the party Lee Iacocca has buttonholed Henry Ford, Thorstein Veblen is reading *What Makes Sammy Run?*, and Dale Carnegie is explaining how to win friends and influence people. The description of the party is sufficiently detailed to set the scene, but vague enough to titillate the reader's imagination about the party goers' conversations. In the final paragraph Baida sounds a warning that Americans have not only lost their capacity to work and save, but also their ability to listen and learn from the past. He concludes that at the present rate the only legacy that Americans will leave future generations is a copy of *Poor Richard's Almanac.* This will allow them to see where American business went wrong.

From an academic perspective, *Poor Richard's Legacy* would make an excellent supplementary text for an introduction to business course. *Poor Richard's Legacy* provides a basis for analyzing American business' ethical dilemma and the problem caused by excessive debt and foreign competition. As a bonus Baida provides an excellent list of sources for future study of the history of American business.

ROBERT G. MORGAN
Professor of Accounting

East Tennessee State University

J. L. G. BOARD, P. F. POPE, and L. C. L. SKERRATT, Editors, *Databases for Accounting Research* (London: The Institute of Chartered Accountants in England and Wales, 1991, pp. vii, 123, £20.00).

Databases for Accounting Research is a monograph commissioned by the Research Board of the Institute of Chartered Accountants in England and Wales to provide accounting researchers with a brief review of several large databases. The monograph will be of interest to academicians conducting research in international accounting since the data included in the datasets range from items from the annual reports of UK companies to analysts' forecasts of earnings per share of US and UK companies to financial information for companies listed on 40 markets.

The book is organized into three sections. The first section evaluates six machine readable databases, the second section provides an overview of 13 data sources which are not, generally, machine readable, and the final section presents a comparison of several of the machine readable databases.

The six machine readable databases reviewed include the Cambridge/DTI Database, Datastream, Exstat Company Accounts Database, Institutional Brokers Estimate System (IBES), London Share Price Database, and MicroExstat. The strengths and weaknesses of the databases are evaluated based on the experiences of researchers who have used them. Although different authors evaluated each of the databases, the same five to six characteristics are reviewed for each. The variables included in each dataset are summarized and the years of available data and the frequency of revision are indicated. The medium on which the data is supplied (magnetic tape, disk, on-line), the cost, and the name and address of the vendor are also noted. To give readers an idea of the potential uses of the databases, a list of recent studies which have employed the databases is included.

The authors of each review also discuss the problems encountered with each database such as the lack of standardization of the format of accounts, inconsistencies in data among companies, and the comparability of data over years and recommend procedures to deal with the problems. Although the summaries are not intended to be substitutes for the database manuals, they do explain how the data is accessed and assess how user-friendly the databases are.

The second section of the monograph provides a summary of 13 other data sources which are available, in general, on microfiche or are published in reports or journals. The sources reviewed range from a monthly magazine dealing with international takeovers, to sources of annual reports, to a cuttings service that chronicles business announcements. Although the analyses of these sources are not as comprehensive as the reviews of the databases, they do include a description of the variables, the method of access, the cost, and the names and addresses of the vendors. The advantages, disadvantages, and potential uses of each dataset are also outlined. Unfortunately, a list of published research that has used the data is provided for only two of the 13 sources.

In the final section of the monograph, several of the databases are compared. The Exstat and Datastream databases are compared as sources of balance sheet and profit and loss data on the basis of relative ease of accessing and using the data, the completeness and accuracy of the data in each, and the ability to reconcile and merge the data from the two sources. The consistency of the price and dividend data from Datastream and the London Share Price Database is also compared. Based on the comparisons, the authors offer suggestions about the types of research questions that are most appropriate for each database.

Databases for Accounting Research is a concise and clearly written guide which provides enough detail to help both new and experienced researchers make choices among the datasets. The monograph is a valuable resource for academicians interested in international accounting research.

HANS J. DYKXHOORN
Professor of Accountancy

Western Michigan University

J. E. BORITZ, *The "Going Concern" Assumption: Accounting and Auditing Implications* (Toronto: The Canadian Institute of Chartered Accountants, 1991, pp. xxvii, 231, C$34.50).

This book is a Research Report sponsored by the Canadian Institute of Chartered Accountants (CICA), with specific CICA objectives:

> ... to assess the accounting and auditing implications of the "going concern" assumption with a particular emphasis on the nature and extent of disclosure required in the financial statements and/or auditor's report when there is insufficient support for the assumption due to significant risks or uncertainties facing the industry or the entity (Foreword).

The report is supposed to provide the basis for a standards project to modify the *CICA Handbook* on both accounting and auditing criteria associated with the "going concern" assumption.

Boritz is quite thorough, if somewhat redundant, in analyzing "going concern" uncertainties, related accounting and auditing responsibilities, and broader questions associated with business failure and bankruptcy. This book should be particularly appealing to readers with an interest in (1) Canadian accounting and auditing issues associated with business failure or (2) comparative national analysis on these issues. Readers interested only in U.S. bankruptcy-related issues may be disappointed. Although U.S. bankruptcy and "going concern" issues are described, the focus is on Canada.

The report presents some useful data. For example, Boritz includes a thoughtful descriptive analysis of 213 Canadian firms with "going concern" qualifications (from the top 1,000 Canadian companies). Researchers wanting to include Canadian companies in a comparative study will also be interested in computer data bases mentioned by Boritz, including CA Online, Info-Globe Database, and Compact Disclosure Canada.

A significant part of the analysis is an international comparison of accounting and auditing standards in other English-speaking countries. This section compares Canadian standards with those of the U.S., United Kingdom, Australia, New Zealand, and the International Accounting Standards Committee. While not identical, these standards are reasonably similar. The U.S. seems to be the "leader" in this area, with other nations following the AICPA's lead (most recently based on Statements on Auditing Standards Nos. 59 and 64). However, Canada seems to be trailing the pack (presumably the reason for this Research Report). Currently, the book is up-to-date on these complex and quickly-changing issues.

Considerable analysis focuses on terminology such as "remote," "possible," and "probable" associated with uncertainties and "significant doubt" and "substantial doubt" associated with SAS No. 59. Boritz tries to relate these to specific probabilities for "going concern" disclosures and related audit report discussion. This may suit the purpose of the CICA, but I found it uncompelling. I find that high classification accuracy and related probabilities from a logit model combined with a matched-pair design tells me little about which firms will declare bankruptcy next year.

Chapter 7 provides a relatively simple explanation of bankruptcy prediction models and related concepts, which may be useful to students and others not familiar with the methodology. Boritz carefully explains Altman's Z-score, reviews financial ratios used by 12 U.S. and four Canadian studies, provides models used in the Canadian studies, and other techniques such as logit and expert systems. Although he could have spent more time explaining logit models, the chapter is an excellent introduction and could be used in the classroom.

Throughout the book there are useful charts and tables summarizing major points comparing existing research studies, describing "going concern" relationships of Canadian firms, and so on. Paging through the book and reviewing the tables may be a worthwhile first step when reading the book. Boritz includes three long appendices. Many readers may find Appendix C, "Rules for Prototype 'Going Concern' Expert Systems," which uses a decision tree approach of particular interest. A Glossary of Terms and an extensive Bibliography are included, but the book lacks an index.

Overall, readers with a broad interest in business failure issues will find the book a useful addition to the literature. The analysis is thorough and up-to-date on "going concern" related issues. The analysis of bankruptcy research also is interesting, although less thorough. The reader is advised to read selectively (most, for example, may not be interested in the recommendations to the CICA for future standard-setting), but the numerous tables and the unique insights of the author are worth the price of the book.

GARY GIROUX
Professor of Accounting

Texas A&M University

FREDERICK D. S. CHOI, *Handbook of International Accounting* (New York: John Wiley & Sons, Inc., 1991, pp. xx, 846, $105.00).

This handbook is a welcome addition to the texts designed "... to assist those whose interests or responsibilities concern the international dimensions of accounting, reporting, and control," as the author/editor states in the preface (p. xv). As a handbook, it is divided into eight major parts. Each part is subdivided into chapters, written by well-known academicians and practitioners with long research records.

Part I, Internationalization of the Accounting Function, contains three chapters dealing with matters related to international corporate finance, financial markets, and financial services industry. These chapters highlight the ever-changing environment of financial management, international competitiveness, and the integration of financial markets. These developments have come about as a result of deregulatory measures and technological changes.

Part II, World Scene of Accounting Practices, illustrates accounting and auditing practices around the world. With the globalization of financial markets, one would assume that accounting reports are prepared on a comparable basis. This is far from the truth. The three chapters in this section of the book highlight the great diversity that exists around the globe related to accounting and auditing standards. The lack of comparability of accounting reports puts users of these reports at a disadvantage when they analyze foreign financial statements.

Part III, International Financial Analysis, highlights in its four chapters further problems associated with international accounting diversity worldwide. It illustrates possible ways of coping with these diversities in conducting financial analysis.

Part IV, International Accounting Harmonization, in its four chapters, deals with efforts made at the national, regional, and international levels to cope with diversity in accounting and auditing standards. This section of the book concludes the coverage of accounting harmonization, and the efforts of different organizations to achieve it.

Parts V through VIII deal with contemporary issues related to the operations of multinational enterprises (MNEs), with the last part dealing with controversial aspects of the operations of MNEs, namely, international transfer pricing policies and taxation.

In summary, the strength of this handbook lies in the fact that it is truly a comprehensive volume, dealing with major contemporary issues in the international accounting field. It is, also, an excellent reference book for individuals involved in international business, in general, and in international accounting, in particular. Therefore, the author/editor is to be congratulated for a job well done. This handbook could be considered as a major textbook or, at least, a supplement to textbooks used in international accounting courses. However, the price may constitute a major drawback. In addition, this handbook would have greater value if each of its major parts had been preceded by a narrative statement which highlights the major issues involved in the section.

DHIA D. ALHASHIM
Professor of Accouting
California State University, Northridge

COOPERS & LYBRAND, *1991 International Accounting Summaries: A Guide for Interpretation and Comparison* (New York: John Wiley & Sons, Inc., 1991, pp. xvi, 667, $95.00).

The rapid globalization of capital markets over the past 20 years has necessitated a better understanding of other countries' financial reporting requirements. Corporate managers, financiers, and investors need to be able to understand the "accounting language" in which foreign entities prepare their financial statements. This publication is a timely addition to resources in the international accounting area as it provides detailed summaries of accounting standards in 24 countries, plus the International Accounting Standards and European Community Directives.

The chapters on individual countries are well organized and follow a standard format. Each chapter starts with an introductory section on sources of accounting and auditing standards and public company requirements in the country. It clearly identifies the specialized industries such as insurance and banking whose accounting rules are not addressed in the chapter. The next section covers general accounting issues including the type of financial statements required, business combinations, and areas of particular relevance to international business like foreign currency translation, inflation accounting, related party transactions, and segment reporting. The third and fourth sections cover accounting principles for specific items in the balance sheet and income statement, respectively.

This book contains several attractive features which make it easy to use for the reader uninitiated in foreign countries' accounting principles. It provides excellent matrices, one for each financial reporting item, which permit easy comparison of the requirements in the 24 countries. The chapters cite references for the source of the country's accounting rule for each financial reporting item. The authors have demonstrated an appreciation of problems arising from linguistic differences. In chapters on non-English speaking countries, significant accounting terms in the native language are included phonetically in parentheses. These are likely to prove helpful to those using foreign annual reports. Additionally, a glossary of accounting terms is provided at the end of the book to prevent confusion from different usage of accounting terms in different English speaking countries.

Another commendable feature of this book is that it specifically deals with accounting requirements only. It avoids the pitfall of switching back and forth between accounting requirements and practices as is the case with others publications such as the Price Waterhouse "*Doing Buiness In . . .*" series. This feature will be welcomed by academics and other conducting research on international accounting issues.

The one area where this publication can improve is in the choice of countries included. The authors acknowlege that "there are other countries which have a rightful claim to be included which will be considered for future editions" (p. Int-2). They list Eastern European countries such as Poland, Hungary, Czechoslovakia, and Yugoslavia as possible candidates. Given the state of flux in these countries, and the growing likelihood that they will adopt standards very similar to EC countries, in my view, their inclusion will not significantly add to the usefulness of this publication. The authors would do well to consider adding countries from Asia (e.g., India, Malaysia, Taiwan, Thailand), South America (e.g., Argentina, Chile, Venezuela), and Africa (e.g., Egypt, Kenya, Zimbabwe). Most of these countries have active stock exchanges and are closer to being market economies than the Eastern European countries. Thus they are more likely to be of interest to analysts and investors. Their inclusion would also provide a better regional balance of countries covered. Inclusion of Saudi Arabia or Bahrain might also be of interest to international businesspeople who are considering doing business in the Middle East but are not familiar with Islamic influences on accounting in countries in the region.

Overall, this book is well organized, clearly written, and as current as can be expected. It will prove to be an excellent source of reference to users attempting to interpret financial reporting information originating in other countries as well as to those comparing specific requirements between countries.

SHAHROKH M. SAUDAGARAN
Assistant Professor of Accounting
Santa Clara University

TOM COPELAND, TIM KOLLER, and JACK MURRIN, *Valuation: Measuring and Managing the Value of Companies* (New York: John Wiley & Sons, 1991, pp. xviii, 428, $34.95).

The premise of this book is that managers of corporations consistently fail to appreciate the link between strategy and finance. Relying on accounting numbers, managers too often pursue actions that systematically undervalue their firms. Undervaluation results in companies that are prime candidates for takeover by managers perceiving the true value of the firm. In order to prevent such actions, the authors present current corporate management with a two-part solution. First, managers must adopt a raider's view of their own firm and determine the extent of its undervaluation. Only by recognizing value creating situations in a firm and identifying restructuring opportunities will managers create the value necessary to deter prospective takeovers. Second, managers must ensure that a value management philosophy permeates the organization. Managers need to view the creation and management of value as an integral part of corporate strategy rather than an activity restricted to the defeat of potential takeovers.

The book contains three sections. The first section consists of chapters one through three. They describe the economic, political, and institutional environment that necessitates managing value. They describe the actual process of managing value within the context of the firm and describe the relationship between discounted cash-flows and valuation. Although these chapters provide the motivation for the remainder of the text, I found the chapters unsatisfyingly shallow and optimistic in several spots. Three points illustrate this concern. First, the authors laud the availability of high-yield bonds for providing financing opportunities for smaller firms and assisting leveraged buyouts. Second, the authors indicate a preference for high levels of debt at the expense of debt ratings. A pessimistic interpretation could legitmately claim that the market for junk bonds and excessive levels of debt represent some of the worst features of corporate business in the free-wheeling 1980s. A more prudent approach would present the pros and cons of these issues. The third point concerns the presentation of academic research in the area of LIFO adoptions to support the point that the market focuses on cash flows rather than earnings. Although admitting the evidence is not entirely conclusive, the authors only present results from Sunder (1973) and Biddle and Lindahl (1982). Market reactions to LIFO adoptions is a methodologically complex area and it is unsettling to see the authors selectively choose studies with findings that support their assertions. In essence, bearing in mind the author's association with McKinsey and Company, my dissatisfaction with this section of the book is that it reads like a sales pitch to prospective clients.

The second section consists of chapters four through eight. These chapters contain a hands-on approach to the valuation of a single business. They present a components discounted cash-flow framework and discuss the calculation of free cash flow and the cost of capital. The chapters discuss the estimation of continuing value and an interpretation of results. These are nuts and bolts chapters that provide explicit instruction on computing the value of a firm. The chapters provide illustrations of the various concepts by extensively applying them to a publicly traded corporation.

The final section consists of chapters nine through thirteen. These chapters apply the valuation framework to more complex situations. These situations include multibusiness companies, multinational companies, mergers and acquisitions, and banks. This section also presents an application of option pricing methods to corporate valuation.

Despite my reservations about the first section, two potential audiences will find this text illuminating. The first group consists of professional managers in need of a systematic approach to understanding the link between strategy and firm value. This book provides managers with a clear understanding of traditional valuation theory and the role that it can play in corporate strategy. The second group consists of academics that desire a supplementary reading for upper-level undergraduates or MBAs in a corporate finance course (or even a strategy course for that matter). The numerous applications of valuation theory will lend credence to the more traditional and theoretical approaches to valuation.

MARC J. LeCLERE
Assistant Professor of Accounting
University of Maryland

GRAEME W. DEAN, FRANK L. CLARK, and O. FINLEY GRAVES, *Replacement Cost and Accounting Reform in Post-World War I Germany* (New York: Garland Publishing, Inc., 1990, pp. xvii, 188, $45.00).

This book is a valuable contribution to accounting history—and a timely one at that, because the issues of inflation accounting are very likely to resurface soon in the context of accounting reforms in Eastern Europe. The volume consists of a translation of 11 articles which appeared in the German literature in 1920. The authors selected (Prion, Mahlberg, Geldmacher, von Schlesinger, Kast, Schulz, Buxbaum, and Schmidt) are among the leading contributors—although some are not well-known in the U.S.—to German inflation accounting ideas. The articles are well translated and cover the entire spectrum of the debate in the early 1920s. To facilitate understanding, a historical introduction, abstracts of all articles, and 18 pages of commentary are provided, pointing out the major issues and relating these to the pertinent English language literature.

The translated manuscripts demonstrate that inflation accounting at the time was not only an economic, but even more so a political issue related to post war reparations. Most of the articles point out the detrimental effect of taxes calculated on historical-cost based profit; taxation of fictitious profits erode the economic viability of enterprises. Geldmacher complained about the "mathematical nonsense" of applying arithmetical procedures to monetary units of different purchasing power. As a remedy accounting based on goldmark indices (the previous currency) is recommended by Mahlberg, whereas others suggest a replacement cost equity adjustment account (expressed in paper marks) which will accumulate measurable differences between historical and replacement cost, thus neutralizing these amounts and keeping them out of the income statement. Although most authors see depreciation as the means to recover asset values and thus assure maintenance of stockholder wealth, Buxbaum stresses that depreciation (related to assets presently used) has nothing to do with building reserves for capital maintenance through the acquisition of future assets, because these may be different in adaptive enterprises. This issue has, unfortunately, not resurfaced in this clarity in later inflation accounting debates in spite of the fact that it is of increased relevance in times of faster asset turnover and more frequent changes in company strategy.

Another issue, underlying Schmidt's "relative capital maintenance" (in his "Organic Accounting" theory), is the selection of appropriate replacement values. Since these are selected either at the time of sale, or in the case of inventories at the time of balance sheet valuation, neither of the two correspond to prices paid at the time of actual replacement. He claims the issue is resolved, if one assumes reinvestment of funds recovered through depreciation in other assets, which will in turn appreciate and thus prevent further erosion by inflation. This concept—which seems to be of questionable validity—has resurfaced again with later authors.

These are only a few observations about the approaches analyzed, which provide insight into the material presented. The authors of the book criticize as a major shortcoming of German inflation accounting theory the implicit or explicit assumption that cost determines prices. This, without any doubt, is a deficiency in a market environment. It is, however, also a criticism which needs modification in the historical context; during that time period cost by-and-large did determine prices due to the war-induced shortages and the prevailing attitude, which determined purchasing behavior under hyper-inflationary conditions.

In summary, the book provides an excellent historical survey of inflation accounting theory in the Germany of 1920. It should be read by accounting historians, by every accountant concerned with today's inflation accounting procedures in Latin America, and by everybody concerned with international accounting issues. Particularly in the context of international consolidation these issues resurface and all the ramifications of inflation accounting need to be fully understood and integrated into modern approaches.

HANNS MARTIN W. SCHOENFELD
Professor of Accountancy
University of Illinois at Urbana-Champaign

NICHOLAS DOPUCH and RONALD R. KING, *Experimental Tests of Auditing as a Credibility Generating Mechanism* (Vancouver: The Canadian Certified General Accountants' Research Foundation, 1991, pp. xii, 87, C$15.00, paper).

This book presents a study of 32 laboratory market experiments designed to examine the voluntary demand for auditing services. These markets consist of a three-person environment (i.e., manager, investor, and auditor) in which single-period contracts are formed between the parties over a multi-period time horizon. Various factors, i.e., auditor moral hazard, and manager versus investor demand for auditing services (as well as who bears the cost of, and receives the information provided by the audit), are analyzed to determine their impact on the voluntary demand for auditors. In general, the results of these experiments suggest that auditor moral hazard decreases both manager and investor demand for auditing services. There is also some evidence that suggests this decrease is more pronounced for manager demand than for investor demand of these services.

In this study, a market consists of one human subject seller (manager), one verifier (auditor) who is either a computerized robot or a human subject, and three human subject buyers (investors). In each period of these forty-period markets, a seller holds either a "low" or "high" type asset that possesses a low or high expected value, respectively. Before the asset is sold to a buyer, a seller decides whether to incur a costly fixed investment that increases the probability he or she holds a high type asset, which increases the expected value of the asset. Subsequent to this investment decision, a seller is subject to moral hazard in that he or she observes the asset's type, but is free to disclose any asset type designation to buyers. Prior to a seller's investment decision, a seller (or buyers in the markets that examine investor demand for auditing) can hire a verifier for a fixed fee to provide a report that either agrees or disagrees with the seller's disclosure. If the verifier is a computerized robot, it incurs an investigation cost, observes the seller's asset type, and truthfully agrees or disagrees with the seller's disclosure (a no moral hazard environment). If the verifier is a human subject, another moral hazard problem exists, for he or she chooses to either (1) incur the investigation cost, observe the asset's type, and decide whether to agree or disagree with the seller's disclosure; or (2) incur no cost and agree with the seller's disclosure. Finally, a buyer purchases the seller's asset via a second price sealed bid institution, and receives a payoff that is a function of randomly assigned payoff values. Given this market environment, the primary variables of interest are a seller's costly investment decision, the decision of whether to hire a verifier, and a human verifier's costly investigation decision.

The focus of this study is clearly an important auditing issue. It also represents an ambitious project; attempting to examine complex three-party behavior, especially over a multi-period time horizon, is a difficult task at best. Modeling such a complex environment often yields a theory that is intractable or ambiguous. This study does not contain extensive theoretical modeling of this environment; rather it presents some theoretical conjectures regarding the effect of treatment conditions on subject behavior. Many of these conjectures are offset by feasible alternative strategies of player behavior, particularly regarding single versus multi-period time horizons. In fact, this study seems to be designed primarily to conduct "heuristic" or exploratory experiments rather than strict theory testing.

This suggests some care need be taken when interpreting the results. While very few of the theoretical point predictions are supported, some of the theoretical conjectures are supported qualitatively, e.g., the effect of verifier moral hazard on seller demand. Other predictions are not supported by the data, e.g., the effect of verifier moral hazard on buyer demand. Additionally, there appears to be significant variation across market replications within some of the treatment cells. These markets are very complex, and often contain alternative feasible player strategies that depend on the beliefs players have about each other. This makes it difficult to interpret intermediate, unexpected, or inconsistent results, and can create ambiguous assessments and comparisons.

The results may also be sensitive to the small sample size. While seller and verifier roles are critical to market behavior and the issues of interest, each market contains only one seller and one verifier, and each treatment cell includes between four and six market replications. This appears to be a small number of critical role subjects from which to infer systematic behavior, and given the large feasible strategy space for players, may have contributed to the variation in behavior across market replications as well as some of the intermediate results.

Overall, this study examines an important auditing issue in a very complex environment. Conducting this worthwhile and difficult task yields some initial results that are of interest to auditing researchers. The findings of this study provide useful insights for producing additional empirical research relating to the demand for audit services as well as inducing theoretical advancements regarding this issue.

JEFFREY W. SCHATZBERG
Assistant Professor of Accounting

University of Arizona

M. R. LAMBERT, D. H. CARTWRIGHT, J. S. CUNNINGHAM, M. H. O'CONNOR, and M. WALSH, *Interim Financial Reporting: A Continuous Process* (Toronto: The Canadian Institute of Chartered Accountants, 1991, pp. xvii, 190, C$34.50, paper).

This research report is the culmination of a project sponsored by the Canadian Institute of Chartered Accountants (CICA). The charge to the Study Group was to review Section 1750 of the CICA Handbook, "Interim Financial Reporting to Shareholders," to determine if changes in the Handbook were necessary. It should be of interest to Canadian accountants as well as those in the United States where APB No. 28 (1973), SFAS No. 3 (1974), and FIN No. 18 (1977) provide the only specific guidelines on interim financial reporting. A review of Accounting Standards issued since 1973 indicates an astounding lack of guidance regarding their applicability to interim financial reporting.

Concern regarding the theoretical deficiencies inherent in current interim reporting standards is clearly evidenced by recent initiatives begun by various interest groups and regulatory agencies in both the Canadian and United States accounting communities. This research report addresses these concerns in an integrated, comprehensive fashion.

The Study Group began with the identification of the users of interim reports and their needs. This information provided the basis for developing an overall framework for interim financial reporting which includes not only financial statements but also management's review and discussion of the results of operations. The report offers 24 recommendations for change addressing such issues as measurement and recognition, presentation, disclosure, and applicability. Probably the most profound recommendation is that "ongoing consideration should be given to the effect on interim reporting when establishing or amending standards for annual financial reporting" (p. xii).

The recommendations were based on the Study Group's analysis of the current environment for interim reporting covering legal requirements, accounting standards, and current reporting practices. The background material for this analysis included a review of accounting and reporting standards and legislation relating to securities. Interestingly, although the review detailed these requirements by province, it was not limited to Canadian standards. It included requirements from both the United States and New Zealand. Information regarding current reporting practices was gathered by surveying 1989/1990 interim financial reports of 150 predominately Canadian companies.

Each interim reporting issue is analyzed in terms of the current legal requirements, authoritative pronouncements, and current practice. An overall assessment is made which relates this information to the objectives of interim reporting and the needs of users. In many instances, the Study Group concluded that enterprises issuing interim financial statements were presenting much more information than currently required by the Handbook. In these cases, the recommendations were simply to bring the "rules" up to the level of current reporting practice.

The Report is quite readable, much of the analysis is reminiscent of the FASB's Conceptual Framework Project and provides relatively few new theoretical insights. However, it evaluates the qualitative characteristics of financial information as they relate *specifically* to interim periods rather than annual periods.

In addition to the theoretical discussion and recommendations, the appendices provide a wealth of data. Appendix D contains a detailed comparison, of CICA Handbook requirements, APB No. 28, and SSAP-24 (New Zealand). Given the current emphasis on the harmonization of accounting standards, this section should be of particular interest to anyone involved in international accounting practices.

For those interested in current practices, Appendix E is particularly informative. It contains the results of the survey conducted to gather the background information for the report. The survey covered over 150 categories of currently reported information including management's report to shareholders, operating summaries, and disclosure of individual statement items. The results are summarized showing numbers of companies presenting particular information by industry classification.

In summary, this research report provides a comprehensive theoretical analysis of interim financial reporting issues and would be of particular interest in either a graduate theory class or an international accounting class.

KATHRYN M. MEANS
Associate Professor of Accounting

Florida Atlantic University

RAJENDRA P. SRIVASTAVA, Editor, *Auditing Symposium X: Proceedings of the 1990 Deloitte & Touche/University of Kansas Symposium on Auditing Problems* (Lawrence, KS: University of Kansas, 1990, pp. ix, 186, $15.00, paper).

This publication codifies the papers, speeches, and presentations comprising the tenth of the biennial symposia held at the University of Kansas and sponsored by Deloitte & Touche. These symposia bring together academics and practitioners to discuss current problems and issues in Auditing.

The symposium continued its generally effective tradition of pairing an academic-author with a practitioner-discussant, and vice versa. Additionally, for the first time, three doctoral candidates (from the University of Kansas) participated, providing a joint discussion of a paper. As another first, a panel participated; this distinguished group of practitioners and one educator discussed the impact of the mergers of accounting firms on the auditing profession.

This publication of the proceedings begins with the keynote address by Ed Kangas of Deloitte & Touche, identifying the "new global realities" and their effects on the auditing profession. The papers and their respective discussant-responses follow, in turn. As in the past, the Symposium chose interesting issues for debate, including the following: (1) teaching ethics in the classroom; (2) a comparison of logistic regression and neural nets methodologies in predicting commercial bank failures; (3) expert systems and artificial intelligence based decision support; (4) potential behavioral biases affecting the use of analytical review procedures as substantive tests; (5) the effects of procedural differences in assessing control risk following the guidance of SAS No. 55 and its predecessor, AU Section 320; and (6) future issues and research needs regarding the auditor's responsibility for detecting illegal acts. The publication concludes with the comments of the distinguished panel. While all the papers provide interesting and informative analyses, three strike me as particularly noteworthy.

"With Firmness in the Right," by Frederick L. Neumann (University of Illinois at Urbana-Champaign), addresses the teaching of ethics in the classroom. Using Abraham Lincoln and some of his notable writings as a frame of reference, the author urges professors to go further in the teaching of ethics than simply generating lively classroom discussion: he challenges us to develop and understand our philosophies of ethics and, then, challenge our students to make a commitment to do what is right, ". . . with firmness in the right, as God gives us to see the right. . . ." I find this paper especially refreshing and particularly profound.

"Analytical Procedure Results as Substantive Evidence," by William R. Kinney, Jr. and Christine M. Haynes (University of Texas at Austin), focuses on the behavioral biases toward incorrect acceptance in applying analytical review procedures as substantive tests. The authors propose a revision of SAS No. 56 to remedy the potential pitfalls. The discussant, Abraham D. Akresh (Independent Consultant, former Partner, Laventhol & Horwath), while generally agreeing with the authors, notes some important issues and distinctions not addressed specifically in the paper; he also provides suggestions for improving SAS No. 56.

"Assessing Control Risk: Effects of Procedural Differences on Auditor Consensus," by Jane E. Morton and William L. Felix, Jr. (University of Arizona), reports the results of experiments designed to test the effects of what the authors identify as conceptual differences between SAS No. 55 and its predecessor, AU Section 320 regarding control-risk-assessment. The discussant, Richard W. Kreutzfeldt (Arthur Andersen & Co. and member of the task force which developed the audit guide for SAS No. 55), challenges the authors' description of SAS No. 55's requirements: labeling it "too literal and too sequential" (p. 135). He also provides his, rather incisive, analysis of the standard.

The papers achieve the objectives of the symposium, making this work potentially appealing to both practitioners and academicians, depending, of course, on the individual's particular interests.

H. JAMES WILLIAMS
Assistant Professor of Accounting

Georgetown University

HOUSTON H. STOKES, *Specifying and Diagnostically Testing Econometric Models* (New York: Quorum Books, 1991, pp. xiii, 337, $55.00).

This book discusses a number of econometric models, gives the assumptions underlying the models, and explains how to use the routines available in the B34S Data Analysis Program for testing the assumptions. The first chapter provides an outline of the book and an overview of the B34S program. The subsequent chapters are topical. Each chapter briefly describes the model(s) covered in the chapter, the specific calculations required, and the related B34S options to perform the calculations. Each chapter also provides worked out examples using the B34S programs. Printouts of the inputs and outputs are given and discussed. The examples are taken from a variety of published sources, to demonstrate the application of different econometric models in different fields.

This is not a textbook on econometrics. As the author states "[t]his book can be thought of as a major extension of the original B34T manual..." (p. 6). However, the author also states "While it is assumed that the reader has a good background in econometrics, obtainable from study of such books as those by Johnston (1963, 1972, 1984), Theil (1971), ..., many of the more advanced statistical procedures are just beginning to appear in econometric textbooks. To aid the reader, the treatment of all techniques discussed in the book is meant to be self-contained" (p. 5).

The author has extensive experience in econometrics and has been actively involved in development of the B34T/B34S programs. This shows in the book. The book contains numerous do's and don'ts as well as discussions of what econometricians commonly do and what they ought to do instead, as illustrated by the following quotes: (1) "Many econometricians only test for first-order serial correlations with the Durbin-Watson statistic. This is often a serious mistake since higher orders of serial correlations may be present in the data. Routine use of the NTAC parameter to calculate higher-order autocorrelations of the residuals will protect against accepting results that are unknowingly contaminated with higher-order serial correlations" (p. 25). (2) "Many users run probit models with 1–0 right-hand-side variables, such as sex and race dummies it makes little sense to evaluate partial derivatives of these 0–1 variables because it is hard to interpret the results" (pp. 59–60). (3) "While 2SLS results are sensitive to the variable that is used to normalize the system, limited information maximum likelihood (LIML) estimation, which can be used in place of 2SLS, is not so sensitive" (p. 97). (4) "All white noise series are *not* pure white noise, unless, in addition, they are Gaussian" (p. 196). (5) "If no tests are made for linearity and Gaussianity, the researcher never knows the properties of the underlying data and is unable to systematically explore alternative models... to reduce the residual sum of squares" (p. 199). In addition, the book provides up-to-date references which a reader will find useful. However, in my opinion, the book is not useful as supplementary reading material for an econometrics course to a graduate student in accounting because (1) a high level of grounding in econometrics is a prerequisite to understand the book, (2) the book is written at an abstract level, lacking motivation, and (3) it is not self-contained.

The book provides varying amounts and different levels of details for different techniques. In my opinion, the best written parts of the book are Chapter 2 (Regression Analysis with Appropriate Specification Tests), Chapter 3 (Logit, Tobit, Probit), Chapter 5 (Error-Components Analysis), and Chapter 9 (Testing the Specification for OLS Equations with Recursive Residuals). These chapters provide good intuitive descriptions and sufficient details of the techniques used to test the model-assumptions. However, as these topics usually receive in-depth coverage in class meetings, the student may not require a supplementary reading book for these topics.

The discussion of the time series techniques (chaps. 7, 8, and 12) is much too formal. These chapters are far from being self-contained and are void of any intuitive explanation. The student must repeatedly refer to other textbooks/articles to fully appreciate what is going on. The student will be better served by reading a standard textbook and SAS manual and then solving some of the end-of-the-chapter problems.

The discussion of the remaining topics—Simultaneous Equation Systems (chap. 4), Markov Probability Analysis (chap. 6), Special Topics in OLS Estimation (chap. 10), Nonlinear Estimation Option in B34S (chap. 11), and Optimal Control Analysis (chap. 13)—is too sketchy. For example, only ten pages of textual material are devoted to simultaneous equation systems. This includes an introduction of the simultaneous equation systems, QR approach solution to the problem associated with accuracy of $(X'X)^{-1}$ in OLS, and estimating the simultaneous equations using OLS, LIML, LS2, LS3, and ILS3. Again, the student will be better served by reading a standard textbook and SAS manual and then solving some of the end-of-the-chapter problems.

To sum up, I find the book to be useful to an accounting researcher engaged in econometric modeling. However, I question its value for an accouting graduate student taking an econometrics course.

RAMESH CHANDRA
Professor of Accounting and Management Science

University of Windsor

WANDA A. WALLACE, *Accounting Research Methods: Do the Facts Speak for Themselves?* (Homewood, IL: Irwin, 1991, pp. xvii, 105, $44.95).

This book is a primer for those interested in consuming research in accounting. It briefly sketches several aspects of the landscape that Ph.D. students (as well as any other consumers of research) must ultimately know well, including categories of research methods, common flaws in research designs, and types of questions investigated by accounting researchers. The main body of the book is short—68 pages—and easy to read even for a research novice; its purpose is to foster awareness and interest, not to explore issues in depth.

Chapter 1 describes the scientific method and provides an overview of various research designs (experimental, archival, analytical, etc.). Chapters 2 and 3 are built around Donald Campbell's well-known threats to internal and external validity. Much of the discussion is similar to what might be found in an early chapter of an experimental design text. The primary difference is that a hypothetical accounting research question (concerning accounting choices made by distressed firms) is used throughout to construct examples of possible research design flaws.

Chapters 4 and 5 examine choices that arise in two crucial aspects of research design, sample selection and the role of assumptions. For example, there is a comparison of random sampling and directed sampling, and a short explanation of the positivist's view of realism in assumptions. Chapter 6 briefly discusses the importance of full disclosure in communicating the results of research. Chapter 7 uses an analogy based on a fisherman's recounting of his success to highlight a checklist of "fishy" claims to beware of in consuming research.

The final major chapter of the book turns from research methods to research issues. Approximately a dozen accounting research topics, ranging from earnings quality to heuristics in individual decision making to field studies in management accounting, are summarized briefly (often within a single paragraph). The 9-page chapter is designed not as a complete taxonomy of accounting research, but as a sampler that could help the reader understand *why* research in accounting could be interesting. The book closes with a 27-page appendix of "jargonese," which defines terms such as homoscedasticity, moral hazard, and intervening variables. The definitions are brief and non-technical—intended only as a reference that sketches key ideas for those new to accounting research.

Accounting Research Methods could be used as an early reading in an initial Ph.D. research seminar, or in a Master's level seminar that introduces research. An alternative would be to combine sources such as Kinney's April 1986 *The Accounting Review* article or excerpts from texts to cover topics in research design, with existing reviews of literature to provide an understanding of accounting research issues. *Accounting Research Methods* would also be appropriate for a given Ph.D. seminar if a single, easy-to-read primer on methods, issues, and jargon were desired prior to turning to more complete treatments.

VICTOR L. BERNARD
Professor of Accounting

University of Michigan

BOOKS RECEIVED NOVEMBER 6, 1991 TO FEBRUARY 6, 1992

AHMED R. BELKAOUI, *Multinational Financial Accounting* (New York: Quorum Books, 1991, pp. xi, 222, $55.00).

JAN BELL, Editor, *Accounting Control Systems: A Technical, Social, and Behavioral Integration* (New York: Markus Wiener Publishing, Inc., pp. iv, 312, $29.95).

PETER W. BERNSTEIN, Editor, *The Ernst & Young Tax Guide 1992* (New York: John Wiley & Sons, Inc., 1992, pp. xxxii, 697, $12.95, paper).

HAROLD BIERMAN, L. TODD JOHNSON, and D. SCOTT PETERSON, *Hedge Accounting: An Exploratory Study of the Underlying Issues* (Norwalk, CT: Financial Accounting Standards Board, 1991, pp. xii, 227, $17.50, paper).

J. L. G. BOARD, P. F. POPE, and L. C. L. SKERRATT, Editors, *Databases for Accounting Research* (London: The Institute of Chartered Accountants in England and Wales, 1991, pp. vii, 123, £20.00).

D. R. CARMICHAEL and MARTIN BENIS, *Auditing Standards and Procedures Manual: 1992* (New York: John Wiley & Sons, Inc., 1992, in 54 sections, $105.00, paper).

FREDERICK D. S. CHOI, *Handbook of International Accounting* (New York: John Wiley & Sons, Inc., 1991, pp. xx, 846, $105.00).

HOWARD R. DAVIA, PATRICK C. COGGINS, JOHN C. WIDEMAN, and JOSEPH T. KASTANTIN, *Management Accountant's Guide to Fraud Discovery and Control* (New York: John Wiley & Sons, Inc., 1992, pp. xvii, 213, $55.00).

SYTSE DOUMA and HEIN SCHREUDER, *Economic Approaches to Organizations* (Hertfordshire, UK: Prentice-Hall International [UK] Ltd., 1992, pp. x, 185, $33.95, paper).

FRANCIS D. FEENEY, *A Guide to International Financial Derivatives* (New York: Quorum Books, 1991, pp. viii, 248, $75.00).

PAUL J. KUZDRALL and ROBERT R. BRITNEY, *Price and Discount Schedule Analysis: A Guide for Purchasing, Marketing, Materials, and Financial Managers* (New York: Quorum Books, 1991, pp. xvi, 257, $59.95).

GEORGE LISLE, Editor, *Encyclopedia of Accounting* (Osaka: Nihon-Shoseki, Ltd., 1991, originally published Edinburgh: Sweet & Maxwell Limited, 1903, pp. 4,076, $1,520.00, 8 volumes).

PETER S. ROSE, *Japanese Banking and Investment in the United States: An Assessment of Their Impact Upon U.S. Markets and Institutions* (New York: Quorum Books, 1991, pp. xiv, 203, $49.95).

ROBERT ROSENTHAL, *Meta-Analytic Procedures for Social Research*, Revised Edition (Newbury Park, CA: Sage Publications, pp. x, 155, $13.95 paper).

J. B. RYAN, B. H. ANDREW, M. J. GAFFIKIN, and T. HEAZLEWOOD, *Australian Company Financial Reporting: 1990* (Caulfield, Victoria, Australia: Australian Accounting Research Foundation, 1991, pp. xx, 310, A$40.00, paper).

ALEXANDER JOHN SANNELLA, *The Impact of GAAP on Financial Analysis: Interpretations and Applications for Commercial and Investment Banking* (New York: Quorum Books, 1991, pp. xxix, 458, $49.95).

VERNON L. SMITH, *Papers in Experimental Economics* (New York: Cambridge University Press, 1991, pp. xvi, 812, $64.95).

PETER B. B. TURNEY, *Common Cents: The ABC Performance Breakthrough* (Hillsboro, OR: Cost Technology, 1992, pp. ix, 322, $19.95, paper).

KAZUO YAMAGUCHI, *Event History Analysis* (Newbury Park, CA: Sage Publications, 1991, pp. ix, 182, $13.95, paper).

NEAL S. ZANK, JOHN A. MATHIESON, FRANK T. NIEDER, KATHLEEN D. VICKLAND, and RONALD J. IVEY, *Reforming Financial Systems: Policy Change and Privatization* (New York: Greenwood Press, 1991, pp. x, 161, $42.95).

EDITORIAL POLICY AND STYLE INFORMATION

EDITORIAL POLICY

According to the policies set by the Publications Committee (which were endorsed by the Executive Committee and were published in the *Accounting Education News*, June 1987), *The Accounting Review* "should be viewed as the premier journal for publishing articles reporting the results of accounting research and explaining and illustrating related research methodology. The scope of acceptable articles should embrace any research methodology and any accounting-related subject, as long as the articles meet the standards established for publication in the journal.... No special sections should be necessary. The primary, but not exclusive, audience should be—as it is now—academicians, graduate students, and others interested in accounting research."

The primary criterion for publication in *The Accounting Review* is the significance of the contribution an article makes to the literature.

The efficiency and effectiveness of the editorial review process is critically dependent upon the actions of both authors submitting papers and the reviewers. Authors accept the responsibility of preparing research papers at a level suitable for evaluation by independent reviewers. Such preparation, therefore, should include subjecting the manuscript to critique by colleagues and others and revising it accordingly prior to submission. The review process is not to be used as a means of obtaining feedback at early stages of developing the research.

Reviewers and associate editors are responsible for providing critically constructive and prompt evaluations of submitted research papers based on the significance of their contribution and on the rigor of analysis and presentation. Associate editors also make editorial recommendations to the editor.

MANUSCRIPT PREPARATION AND STYLE

The Accounting Review's manuscript preparation guidelines follow (with a slight modification) the B-format of the *Chicago Manual of Style* (13th ed.; University of Chicago Press). Another helpful guide to usage and style is *The Elements of Style*, by William Strunk, Jr., and E. B. White (Macmillan). Spelling follows *Webster's International Dictionary*.

FORMAT

1. All manuscripts should be typed on one side of 8½ × 11″ good quality paper and be double spaced, except for indented quotations.
2. Manuscripts should be as concise as the subject and research method permit, generally not to exceed 7,000 words.
3. Margins of at least one inch from top, bottom, and sides should facilitate editing and duplication.
4. To assure anonymous review, authors should not identify themselves directly or indirectly in their papers. Single authors should not use the editorial "we."
5. A cover page should show the title of the paper, the author's name, title, and affiliation, any acknowledgements, and a footnote indicating whether the author would be willing to share the data (see last paragraph in this statement).

Pagination: *All* pages, including tables, appendices, and references, should be serially numbered. The first section of the paper should be untitled and unnumbered. Major sections may be numbered in roman numerals. Subsections should not be numbered.

Numbers: Spell out numbers from one to ten, except when used in tables and lists, and when used with mathematical, statistical, scientific, or technical units and quantities, such as distances, weights, and measures. For example: *three days*; *3 kilometers*; *30 years*. All other numbers are expressed numerically. Generally when using approximate terms spell out the number, for example, *approximately thirty years*.

Percentages and Decimal Fractions: In nontechnical copy use the word *percent* in the text; in technical copy the symbol % is used. (See the *Chicago Manual* for discussion of these usages.)

Hyphens: Use a hyphen to join unit modifiers or to clarify usage. For example: a *well-presented analysis*; *re-form*. See *Webster's* for correct usage.

Key Words: The synopsis is to be followed by four *key words* that will assist in indexing the paper.

SYNOPSIS

A synopsis of about 400 words should be presented on a separate page immediately preceding the text. The synopsis also serves as the "introduction." The synopsis should be nonmathematical and include a readable summary of the research question, method, and the significance of the findings and contribution. The title, but not the author's name or other identification designations, should appear on the synopsis page.

TABLES AND FIGURES

The author should note the following general requirements:

1. Each table and figure (graphic) should appear on a separate page and should be placed at the end of the text. Each should bear an arabic number and a complete title indicating the exact contents of the table or figure.
2. A reference to each graphic should be made in the text.
3. The author should indicate by marginal notation where each graphic should be inserted in the text.
4. Graphics should be reasonably interpreted without reference to the text.
5. Source lines and notes should be included as necessary.

Equations: Equations should be numbered in parentheses flush with the right-hand margin.

DOCUMENTATION

Citations: Work cited should use the "author-date system" keyed to a list of works in the reference list (see below). Authors should make an effort to include the relevant page numbers in the cited works.

1. In the text, works are cited as follows: authors' last name and date, without comma, in parentheses: for example, (Jones 1987); with two authors: (Jones and Freeman 1973); with more than two: (Jones et al. 1985); with more than one source cited together (Jones 1987; Freeman 1986); with two or more works by one author: (Jones 1985, 1987).
2. Unless confusion would result, do not use "p." or "pp." before page numbers: for example, (Jones 1987, 115).
3. When the reference list contains more than one work of an author published in the same year, the suffix *a*, *b*, etc. follows the date in the text citation: for example, (Jones 1987a) or (Jones 1987a; Freeman 1985b).
4. If an author's name is mentioned in the text, it need not be repeated in the citation; for example, "Jones (1987, 115) says. . . ."
5. Citations to institutional works should use acronyms or short titles where practicable; for example, (AAA ASOBAT 1966); (AICPA Cohen Commission Report 1977). Where brief, the full title of an institutional work might be shown in a citation: for example, (ICAEW *The Corporate Report* 1975).
6. If the manuscript refers to statutes, legal treatises, or court cases, citations acceptable in law reviews should be used.

Reference List: Every manuscript must include a list of references containing only those works cited. Each entry should contain all data necessary for unambiguous identification. With the author-date system, use the following format recommended by the *Chicago Manual*:

1. Arrange citations in alphabetical order according to surname of the first author or the name of the institution responsible for the citation.
2. Use author's initials instead of proper names.
3. Dates of publication should be placed immediately after author's name.
4. Titles of journals should not be abbreviated.
5. Multiple works by the same author(s) should be listed in chronological order of publication. Two or more works by the same author(s) in the same year are distinguished by letters after the date.
6. Inclusive page numbers are treated as recommended in *Chicago Manual* section 8.67.

Sample entries are as follows:

American Accounting Association, Committee on Concepts and Standards for External Financial Reports. 1977. *Statement on Accounting Theory and Theory Acceptance*. Sarasota, FL: AAA.

Fabozzi, F., and I. Pollack, eds. 1987. *The Handbook of Fixed Income Securities*. 2d ed. Homewood, IL: Dow Jones-Irwin.

Demski, J. S., and D. E. M. Sappington. 1989. Hierarchical structure and responsibility accounting. *Journal of Accounting Research* 27 (Spring): 40–58.

Dye, R., B. Balachandran, and R. Magee. 1989. Contingent fees for audit firms. Working paper, Northwestern University, Evanston, IL.

Kahneman, D., P. Slovic, and A. Tversky, eds. 1982. *Judgment Under Uncertainty: Heuristics and Biases*. Cambridge, United Kingdom: Cambridge University Press.

Porcano, T. M. 1984a. Distributive justice and tax policy. *The Accounting Review* 59 (October): 619–36.

———. 1984b. The perceived effects of tax policy on corporate investment intentions. *The Journal of the American Taxation Association* 6 (Fall): 7–19.

Shaw, W. H. 1985. Empirical evidence on the market impact of the safe harbor leasing law. Ph.D. dissertation, University of Texas, Austin.

Sherman, T. M., ed. 1984. *Conceptual Framework for Financial Accounting*. Cambridge, MA: Harvard Business School.

Footnotes: Footnotes are not used for documentation. Textual footnotes should be used only for extensions and useful excursions of information that if included in the body of the text might disrupt its continuity. Footnotes should be double spaced and numbered consecutively throughout the manuscript with superscript Arabic numerals. Footnotes are placed at the end of the text.

SUBMISSION OF MANUSCRIPTS

Authors should note the following guidelines for submitting manuscripts:

1. Manuscripts currently under consideration by another journal or other publisher should not be submitted. The author must state that the work is not submitted or published elsewhere.
2. In the case of manuscripts reporting on field surveys or experiments, four copies of the instrument (questionnaire, case, interview plan, or the like) should be submitted.
3. Four copies should be submitted together with a check in U.S. funds for $50.00 for members or $100.00 for nonmembers of the AAA made payable to the American Accounting Association. Effective January 1990, the submission fee is nonrefundable.
4. The author should retain a copy of the paper.
5. Revisions must be submitted within 12 months from request, otherwise they will be considered new submissions.

COMMENTS

Comments on articles previously published in *The Accounting Review* will be reviewed (anonymously) by two reviewers in sequence. The first reviewer will be the author of the original article being subjected to critique. If substance permits, a suitably revised comment will be sent to a second reviewer to determine its publishability in *The Accounting Review*. If a comment is accepted for publication, the original author will be invited to reply. All other editorial requirements, as enumerated above, also apply to proposed comments.

POLICY ON REPRODUCTION

An objective of *The Accounting Review* is to promote the wide dissemination of the results of systematic scholarly inquiries into the broad field of accounting.

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POLICY ON DATA AVAILABILITY

The following policy has been adopted by the Executive Committee in its April 1989 meeting.

"An objective of (*The Accounting Review, Accounting Horizons, Issues in Accounting Education*) is to provide the widest possible dissemination of knowledge based on systematic scholarly inquiries into accounting as a field of professional, research, and educational activity. As part of this process, authors are encouraged to make their data available for use by others in extending or replicating results reported in their articles. Authors of articles which report data dependent results should footnote the status of data availability and, when pertinent, this should be accompanied by information on how the data may be obtained."

JULY 1992 PLACEMENT ADS

The deadline for information to be included in the "Placement Information" section is two months prior to the date of publication. The Review is published on the first day of January, April, July, and October. Placement advertising and replies should be sent to the American Accounting Association, 5717 Bessie Drive, Sarasota, FL 34233. ATTENTION: ADVERTISING DEPT. All replies to box numbers should be on separate sheets to facilitate forwarding. There is no charge for this service to AAA members and associate members seeking employment. Others will be charged a fee of $150 per insertion. ADS SHOULD NOT EXCEED 150 WORDS.

#301 THE UNIVERSITY OF RICHMOND. Resumed search. Applications are invited for a tenure-track accounting position in taxation at the Assistant or Associate level starting Fall 1993. A Ph.D. or DBA is required (ABD considered). Necessary qualifications include commitment to teaching excellence and quality research. Teaching is at the undergraduate and MBA levels with a maximum of 9 hours per semester. The University's School of Business and the undergraduate accounting program are both accredited by the AACSB. The University is a heavily endowed 3,500 student private institution located on a beautiful residential campus at the edge of Richmond, Virginia. Salaries are competitive with AACSB accredited schools and fringe benefits are excellent. Summer teaching and research opportunities are available. The University of Richmond is an Equal Opportunity, Affirmative Action Employer and encourages applications regardless of race, sex, age, religion, national origin, or physical disability. Send vita and references to Dr. Francis A. Bird, Chair, Accounting Department, E. Claiborne Robins School of Business, University of Richmond, VA 23173.

#302 POSITION WANTED: Ph.D., C.P.A. Good teacher with considerable experience in academic administration. Twenty-three years teaching undergraduates and graduates. Prefer a one year contrack beginning Fall 1992. Subsequently a tenure stream position may be of interest.

#303 THE UNIVERSITY OF NEVADA, RENO anticipates one tenure-track position in Accounting commencing July 1993. Candidates in auditing are preferred although other qualified candidates may be considered. Candidates should possess a Ph.D./DBA or be in the later dissertation stage of such degrees. Senior appointments require a solid publication record. Campus enrollment is 12,500 students with approximately 2,000 enrolled in AACSB-accredited undergraduate and master business programs. Competitive salaries with excellent benefits are available. Send vita to: Chair of the Search Committee, Accounting & Computer Information Systems Department, College of Business Administration, Mail Stop 026, University of Nevada, Reno, Nevada 89557. The screening of applications will commence on September 15th, 1992 and applications must be received by that date to ensure full consideration. Applications received after that date will be considered in the event that the position is not filled. AA/EOE.

#304 Very prolific tenured Associate Professor (Ph.D.) seeking a full-time (academic, administrative, research and/or a combination) position in a Accounting Department/Business School or Research Institute. My teaching experience of over the past 10 years (at the University of Miami) includes: Financial/Managerial/Cost/Forensic Auditing and Accounting, Accounting Research Methods/ Expert System and Artificial Intelligence/Quantitative Methods/Information Systems in Accounting as well as Computer Auditing/Programming for graduate/undergraduate/executive and professional courses. I have enjoyed teaching, advising students, researching and publishing, supervising thesis, consulting and interacting with the community/professionals.

#305 THE FACULTY OF ACCOUNTING AND LAW at the State University of New York at Albany seeks candidates for tenure-track positions in September, 1993 in the areas of (1) Auditing, (2) Financial, (3) Taxation, and (4) Accounting Information Systems. The expected initial workload is teach two sections per semester, fulfill normal service obligations and pursue research and publication in qualified journals. Applicants should have an appropriate doctorate or be in the advanced stage of dissertation research by May, 1993. The salary will be competitive and commensurate with professional qualifications. Applications are sought from all ranks; minority candidates are especially encouraged to apply. Representatives will be attending the AAA Convention in Washington, D.C. August 9-13, 1992. Send resumé to Professor Roland Minch, Chair, Faculty of Accounting and Law, State University of New York at Albany, NY, 12222. The State University of New York at Albany is an Equal Opportunity/Affirmative Action Employer.

#306 SAINT LOUIS UNIVERSITY invites nominations and applications for an ERNST & YOUNG ACCOUNTING PROFESSORSHIP. Qualifications include an earned accounting doctorate, a significant record of scholarly publication, and a strong continuing commitment to excellence in research and teaching in financial accounting, management accounting, auditing or accounting information systems. Responsibilities will include active participation in the Ph.D. program. Salary and fringe benefits are very competitive. Saint Louis University is a private Jesuit institution in the heart of metropolitan St. Louis. The School of Business and Administration is AACSB accredited with competitive admission standards. The Department of Accounting provides programs leading to the Ph.D., MPA and BS degrees. Send correspondence to John N. Kissinger, School of Business and Administration, Saint Louis University, 3674 Lindell Boulevard, St. Louis, Missouri 63108. Applications will be accepted until the position is filled. Saint Louis University is an Equal Opportunity, Affirmative Action Employer. Minorities and women are encouraged to apply.

#307 THE SCHOOL OF ACCOUNTING AT OKLAHOMA STATE UNIVERISTY is seeking applicants for the Kerr-McGee Chair in Accounting. Applicants should possess a distinguished record of teaching and research and be capable of assuming a major role in the academic and professional missions of the School. Activities of the chair holder are expected to include teaching and scholarly research, contributing to the research activities of the faculty, and active participation in the doctoral program. The initial appointment is for three years, renewable thereafter at three-year intervals. Benefits beyond the resources and privileges accorded School of Accounting faculty members include a salary and travel supplement, a six-hour per semester teaching load, and summer research support. The deadline for applications is December 31, 1992. Applicants should send resumés to Dr. Lanny G. Chasteen, Head, School of Accounting, Oklahoma State University, Stillwater, OK 74078-0555. OSU is an Equal Opportunity, Affirmative Action Employer.

#308 LEHIGH UNIVERSITY invites applications for a tenure-track position beginning Fall 1993. Although preference will be given to applicants at the assistant professor level, candidates who show evidence of excellence in teaching and substantial research productivity will also be considered for the associate rank. Candidates must have a Ph.D., DBA, or be near completion. The applicant should have a primary interest in **financial accounting** and/or **information systems**. The Department seeks a balance between teaching performance and research productivity. Our undergraduate programs are fully accredited, including Type A accounting accreditation, as is our college MBA program. Please submit applications before November 13, 1992. Contact: Kenneth P. Sinclair, Chair, Department of Accounting, Lehigh University, Rauch Business Center #37, Bethlehem, PA 18015. Lehigh is a Equal Employment Opportunity/Affirmative Action Employer.

#309 UNC-WILMINGTON: Cameron Professor of Accountancy. The University of North Carolina at Wilmington is seeking nominations and applications for the Cameron Professor of Accountancy. The appointment of the Professorship will be for a period of one to three years, and may be renewable. The basic qualifications are Ph.D./DBA, a record of excellence in teaching, and an ongoing stream of research and publication. The Cameron School of Business Administration, with 55 full-time faculty, offers courses to 1,600 students in its various undergraduate and graduate programs. The Department of Accountancy and Business Law has 13 full-time faculty and over 250 majors. Applications and nominations should be mailed to: Dr. Stephen M. Courtenay, UNC-Wilmington, 601 South College Road, Wilmington, North Carolina 28403-3297. A representative will also be at the National AAA Convention in August. To make arrangements for a meeting, please call (919) 395-3818 prior to August 1, 1992. The University of North Carolina at Wilmington is an Equal Employment Opportunity/Affirmative Action Employer.

#310 THE UNIVERSITY OF MANITOBA is seeking applicants for tenure-track positions in accounting for July 1992. Rank and salary open, based on qualifications and experience. A visiting appointment is also possible. Ph.D. or DBA, completed or near completion, is required. Duties include research teaching at the undergraduate and graduate levels. Salary is competitive and will depend on qualifications, experience and research record. Winnipeg, a multicultural city of 600,000 offers the best of an urban environment in the heart of Canada's vacation land. The University of Manitoba encourages applications from qualified women and men, including members of visible minorities, aboriginal people and persons with disabilities. The University provides a smoke free work environment safe for specially designated areas. Priority consideration will be given to Canadian citizens and permanent residents. Applications should be sent to: Dr. Lawrence I. Gould, Head, Department of Accounting and Finance, University of Manitoba, Winnipeg, Manitoba R3T 2N2.

#311 ILLINOIS STATE UNIVERSITY is seeking applicants for the position of Department of Accounting Chairperson. The anticipated date of appointment is July 1, 1993. The department includes thirty-two faculty lines in Accounting and in Business Information Systems. Approximately 450 undergraduate students (juniors and seniors) and 35 master students are currently majoring in Accounting. In addition, about 100 students are enrolled in a Business Information Systems sequence of courses offered by the department. The Department of Accounting has recently achieved accreditation of its bachelor's and master's Accounting programs from the American Assembly of Collegiate Schools of Business (AACSB). Applicants should forward a vita and three letters of recommendation to: Dr. Charles McGuire, Chairperson, Finance & Law - 5480, College of Business, Illinois State University, Normal, Illinois 61761. (309) 438-8777. Representatives of the Department will attend the AAA Annual Meeting in Washington, D.C. to interview candidates. ISU is an Equal Opportunity Employer.

#312 GEORGE MASON UNIVERSITY. The Department of Accounting invites applications at all academic ranks for positions beginning September 1993. Ph.D. or DBA (or completion by appointment date) required. Preference for experienced individuals in areas of auditing, managerial, or taxation. Candidates for assistant professor positions should have potential for excellence in teaching and research. Candidates for positions at higher ranks should have an established record of excellence in teaching and research. George Mason University is a state supported institution located in the Washington, D.C. metropolitan area. The School of Business Administration offers AACSB business and accounting accredited undergraduate and graduate degree programs. Applicants should send vita, transcripts, references, research proposals and/or samples of research to: Dr. Kenneth Heller, Department Chair, Accounting & Business Legal Studies Department, Robinson B Room 441, George Mason University, Fairfax, VA 22030-4444. George Mason University is an Affirmative Action/Equal Opportunity Employer.

#313 UNIVERSITY OF SOUTHERN MAINE. The Department of Accounting has an anticipated opening for a tenure-track assistant professor. Teaching needs are in the areas of graduate managerial accounting and undergraduate auditing or advanced financial. Teaching effectiveness is emphasized with scholarly activity expected. Starting date: January 1, or September 1, 1993. Candidates will have Ph.D. or DBA in accounting. Individuals at an advanced stage of ABD would be eligible for a one year appointment at the Lecturer rank with conversion to tenure-track upon completion of degree within that year. Experience and CPA/CMA are positive additional factors. Preliminary interviews will be conducted at the Washington, DC AAA meeting. Send letter of application, vita, and list of three references to: Dr. Philip Jagolinzer, University of Southern Maine, School of Business, Economics and Management, RE: 106, 96 Falmouth Street, Portland, ME 04103. Review of applications will begin immediately and continue until position is filled. EEO/AA Employer.

#314 UNIVERSITY OF LOUISVILLE, ASSISTANT PROFESSOR OF ACCOUNTANCY. An appointment as Assistant Professor of Accountancy may be available for Fall 1993. Minimum qualifications are: Ph.D. or DBA in accounting, potential for teaching effectiveness; quality research capabilities. ABDs will be considered if substantial progress has been made on the dissertation. Preference will be given for possession of CPA, CMA or CIA certification and/or established publication record. Preferred area of teaching and research is taxation with any secondary interest. Deadline for application is September 1, 1992. The Accountancy Program is accredited by AACSB. If you wish to take advantage of this opportunity, send your vita to: Dr. Alan Attaway, Chairman, Department of Accountancy, School of Business, University of Louisville, Louisville, Kentucky 40292. EEO/AA Employer.

#315 THE UNIVERSITY OF TULSA School of Accounting invites applications for the Chapman Professorship in Accounting for August 1993. Candidates should possess an outstanding record of research productivity and teaching effectivesness. The successful candidate should provide scholarly leadership and teach upper-level and graduate financial accounting courses. Salary is negotiable. Application deadline is November 30, 1992. The College of Business is fully AACSB accredited. The University of Tulsa is an independent institution with excellent community support for accounting. Cultural, recreational and quality living opportunities abound. Send vita and references to Gordon L. Nielsen, Director, School of Accounting, The University of Tulsa, 600 South College Avenue, Tulsa, OK 74104-3189; telephone 918-631-2217. The University of Tulsa, an Equal Opportunity/Affirmative Action Employer, is committed to diversifying its faculty and staff. Members of underrepresented groups are strongly encouraged to apply.

#316 ST. MARY'S UNIVERSITY SCHOOL OF BUSINESS AND ADMINISTRATION seeks to fill a vacancy in Accounting at Associate or Full Professor level. Candidates must have proven academic record of quality University level teaching and research and value close faculty-student interaction. Earned Ph.D. or DBA in Accounting required. Previous business-world Accounting or Auditing experience and CPA/CMA certification desirable. Departmental priority needs are in Accounting Information Systems and Fund Accounting. Salary competitive depending upon rank and experience. Position will be filled for the Fall 1983 semester. Initial application requires letter, current resumé, and examples of current research. Submit applications by September 30, 1992. Initial interviews will be conducted at AAA Annual Meeting in Washington, D.C. during August 8-12, 1992. Reply to: Dr. Adrian Kline, Chair, Department of Accounting, St. Mary's University, San Antonio, Texas 78228-8607. (512) 436-3705. An EEO/AA Employer.

#317 MASSEY UNIVERSITY, PALMERSTON NORTH, NEW ZEALAND invites applications for Senior Lecturers (Assistant Professors) and an Associate Professor in Accountancy. The Division of Accountancy is seeking suitably qualified applicants to stregthen its teaching and research capabilities in all areas of Accountancy. Applicants may be qualified in any areas of Accounting and Auditing. Appointees will be required to teach in courses offered at undergraduate, postgraduate and post-experience levels and to contribute to research. Opportunities exist for innovative teaching approaches. Enquiries should be addressed to Professor Mohan Lal, Head of Division of Accountancy, Massey University, Private Bag, Palmerston North, New Zealand. Telephone (64) (6) 350-5259. Facsimile (64) (6) 350-5617. Professor Lal will be attending the AAA meeting, 9-12 August, 1992 in Washington, D.C., and would be pleased to meet with interested candidates. Massey Unversity is an Equal Opportunity Employer.

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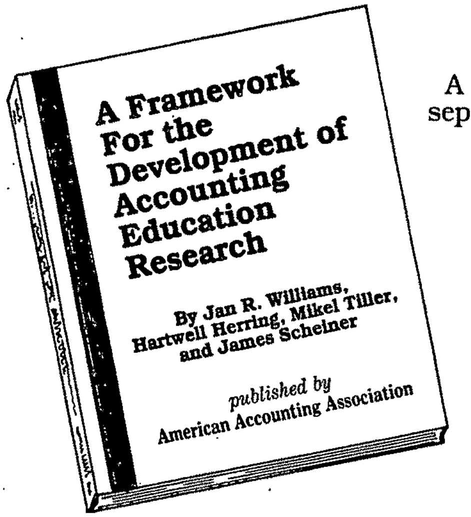
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AMERICAN ACCOUNTING ASSOCIATION

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***Editor's Note:* This manuscript was the 1991 winner of the AAA Competitive Manuscript Contest.**

Relative Performance Information: The Effects of Common Uncertainty and Contract Type on Agent Effort

James R. Frederickson
Indiana University

SYNOPSIS AND INTRODUCTION: Relative performance evaluation (RPE) is the process of comparing performances across workers. Relative performance information (RPI) allows a superior to better infer a particular worker's unobservable effort level than would otherwise be possible, and analytical studies have demonstrated that RPE may be an optimal strategy for mitigating the effects of moral hazard if the workers face some common uncertainty (Baiman and Demski 1980; Holmstrom 1980, 1982; Wolfson 1985).

Although these analytical studies provide important insights into the role of RPE, they ignore the intrinsic value of comparing workers' performances as asserted (Locke 1968) or demonstrated (Beck and Seta 1980; Harkins and Jackson 1985; Klinger 1969) in behavioral studies. Holmstrom (1982, 325) specifically states that "inducing competition among [workers] by tying their rewards to each other's performance has no intrinsic value." That is, formal models do not assign any intrinsic value to RPE because they emphasize the economic rather than behavioral factors that influence workers' responses to RPE.[1]

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[1] Economic factors are defined as those typically assumed to affect utility in economic models, namely compensation and effort. Behavioral factors are defined as unobservable, nonpecuniary influences on a

I am grateful for the helpful comments of James Jiambalvo, Jamie Pratt, Gary Sundem, John Friedlan, Michel Magnan, Eric Noreen, and Gerald Salamon and the participants of the accounting workshop at Indiana University. I would also like to acknowledge the participants of the accounting workshops at the University of Arizona, Michigan State University, University of Notre Dame, Oregon State University, University of Wisconsin, and especially the University of Washington for their comments on earlier drafts of this paper. The help of Phil Beaulieu, John Friedlan, and Sue Kenney in conducting the experiment is greatly appreciated. The Arthur Andersen & Co. Foundation provided financial support for this research project.

Submitted December 1990.
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Consideration of the direct effects of both behavioral and economic factors on effort can provide a better understanding of the potential benefits from RPE. In this study, variables suggested by formal models—that of Holmstrom (1982) in particular—are used to examine the importance of economic and behavioral factors in explaining the motivational effects of comparing workers' performances. Specifically, the direct effects on effort of (1) the degree of common uncertainty among the workers and (2) compensation as a function of RPI are examined in a setting where workers know that they and their supervisor will receive RPI. Several assumptions of agency theory are used to develop hypotheses about the importance of economic factors, and social influence research is used to develop hypotheses about the importance of behavioral factors.[2]

The hypotheses were tested in a laboratory experiment that required subjects to act as managers and make production decisions for a hypothetical company. Half the subjects worked under a profit-sharing contract that based compensation solely on their absolute performance, and the remaining subjects worked under an RPE contract that based compensation on both their absolute performance and performance relative to the RPI. There were three levels of common uncertainty, and it was manipulated by varying the number of sources of uncertainty that subjects had in common. Subjects' risk and effort preferences were induced experimentally.

The experimental results support the importance of both economic and behavioral factors, depending on the type of contract examined. Subjects' effort levels increased significantly as the degree of common uncertainty increased with the RPE contract, but not with the non-RPE contract. In addition, effort levels were higher under the RPE contract than under the non-RPE contract. These results imply that behavioral factors can be important determinants in motivating effort and that future attempts to model behavior analytically may need to consider these factors. The results also provide weak evidence that economic factors, such as contract type, may enhance or mitigate the importance of behavioral factors in motivating effort.

Key Words: *Common uncertainty, Multi-agent, Relative performance evaluation, Social influence.*

Data Availability: *Data are available from the author upon request.*

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person's decision-making process. An example is the tendency to work harder when performance will be compared with that of others in similar situations even if compensation is not specifically tied to the performance rank.

[2] Because this study examines the importance of both economic and behavioral factors, it provides evidence about the potential fruitfulness of incorporating both into formal models. However, this study does not constitute a test of agency theory. In particular, evidence that behavioral factors exert a systematic influence is not interpretable as a refutation of agency theory.

THE remainder of this article is organized as follows. The hypotheses are developed in the next section, and the experimental method and related design issues are presented in section II. In section III, the data are analyzed. The results are summarized and discussed in section IV.

I. Development of Hypotheses

The first part of this section provides background for understanding the basics of RPI. The hypotheses tested in this study arise from two different literatures. The first addresses the informational role of RPI, and the hypotheses that arise from this literature are labeled economic hypotheses. The second addresses the behavioral role of RPI as developed in social influence research, and the hypotheses that arise from this literature are labeled behavioral hypotheses.

Background

Consider a situation in which a risk-neutral principal employs a single risk- and effort-averse agent.[3] The agent takes an action, a, on behalf of the principal that together with a random state of nature, s, determines the outcome, x. If the principal cannot observe either a or s, the principal can use x as a signal about a. Agency theory suggests that in such cases, the principal should base the sharing rule with the agent, $m(\bullet)$, on x to provide the agent with an incentive to exert more effort than he or she would otherwise (Baiman 1982; Demski and Feltham 1978; Namazi 1985). However, since x is a joint function of a and s, x is a noisy signal about a. This implies that a contract of the form $m(x)$ imposes risk on the risk-averse agent and results in inefficient risk sharing between the principal and the agent. In addition, the agent exerts less effort under this contract than if the principal could observe the agent's effort level (Gibbons and Murphy 1989). Thus, basing the agent's compensation on x results in a second-best solution.

Holmstrom (1979) proves that if a signal, y, provides information about a or s over that provided by x alone, the pair (x,y) provides a less noisy signal about a than that provided by x alone. This implies that y is valuable for contracting and that basing the agent's compensation on the pair (x,y) can either (1) improve risk sharing between the principal and the agent without reducing the agent's incentive to exert effort or (2) provide the agent with greater incentives to exert effort without imposing additional risk on the agent (Gibbons and Murphy 1989; Holmstrom 1979, 1982). Thus, a contract of the form $m(x,y)$ dominates $m(x)$ if y is informative.

Several analytical studies have examined informative signals in multi-agent environments (Baiman and Demski 1980; Holmstrom 1980, 1982; Wolfson 1985). Specifically, these studies have examined the role of RPI in improving the efficiency of agents i's contract.

In particular, Holmstrom (1982) examines the informativeness of RPI in a setting with a risk-neutral principal who employs n risk- and effort-averse agents for one period. Each agent takes an independent, noncollusive action a_i, $i=1,2,\ldots,n$, on behalf of the principal that combines with a random state of nature, s_i, to determine each agent's output, x_i. Let $\mathbf{x}=(x_i,\ldots,x_n)$ be the vector of outputs for the n agents.

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[3] Agency theory and organizational behavioral theories use different terms to refer to workers. For consistency, the term agent is used throughout the article to refer to workers.

The uncertainty that agent *i* faces can be partitioned into that shared by the *n* agents and that specific to agent *i*. Thus, x_i is a function of (1) agent *i*'s effort, (2) a stochastic process common to the *n* agents, and (3) a stochastic process idiosyncratic to agent *i*. Holmstrom (1982) proves that **x** provides information about the effect of the common stochastic process on agent *i*'s output, which allows the principal to filter the effect of the common uncertainty from agent *i*'s evaluation and better infer agent *i*'s unobservable effort level than if the principal is able to observe only x_i. Thus, if the agents face some common uncertainty, **x** is marginally informative about agent *i*'s effort level and the optimal sharing rule takes the form $m_i(x_i,\mathbf{x})$.[4] These results are consistent with Baiman and Demski (1980) and Wolfson (1985).

Although RPI is informative, it is usually a noisy signal because each agent faces some idiosyncratic uncertainty. However, in conformance with Holmstrom's (1979) informativeness concept, if the proportion of common uncertainty to total uncertainty increases, the signal-to-noise ratio of RPI increases, and RPI becomes more informative. Thus, RPI should become more valuable for contracting as the degree of common uncertainty increases.

The direct effect on effort of incorporating RPI into an agent's compensation scheme is examined in this study by performance comparisons under two different contracts: (1) a profit-sharing contract in which agent *i*'s compensation is not a function of RPI and (2) an RPE contract in which agent *i*'s compensation is a function of RPI.[5] The RPE contract is identical to the profit-sharing contract except that it has an added relative performance component that compensates (penalizes) agent *i* for each unit of output greater (less) than the average output of agent *i*'s comparison group.[6] Holmstrom (1982) shows that "aggregations of individual performance measures may be sufficient bases for relative performance evaluation" (Antle and Smith 1986, 5).

This study is interested in the *direct* effect on effort of increasing the degree of common uncertainty. Analytical models suggest that a change in the contracting environment, such as increasing the uncertainty shared by the agents, should lead to a modification of the contract or the contract parameters. However, any effort effects that are a result of modifying the contract parameters would be an *indirect* effect of increasing the degree of common uncertainty. To isolate the direct effects of changes in the degree f common uncertainty on effort from the indirect effects, the contract parameters are eld constant as the degree of common uncertainty increases.[7]

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[4] If the agents share no uncertainty, the x_is are independent, and **x** does not provide any incremental information about agent *i*'s unobservable effort level over that provided by x_i. In this case, the principal's optimization problem reduces to *n* single-agent optimization problems, and the optimal sharing rule is $m_i(x_i)$ (Holmstrom 1982). Alternatively, if the uncertainty that agent *i* faces is completely shared with the other agents, the principal can infer the state of nature affecting x_i, and can thereby effectively observe agent *i*'s effort level. Hence, when the agents share complete common uncertainty, **x** can be used to achieve the first-best solution (Holmstrom 1982; Wolfson 1985). If agents' outputs are not individually observable, the principal compensates the agents as a team, which can lead to a free-rider problem. See Alchian and Demsetz (1972) or Holmstrom (1982) for a discussion of this problem.

[5] The compensation schemes are expressed as follows: For the profit-sharing contract, $m_i=f+j(p\bullet x_i)$; for the RPE contract, $m_i=f+j(p\bullet x_i)+q(x_i-y_i)$, where m_i is agent *i*'s salary (profit sharing: $f\leq m_i\leq 2f$; RPE: $0\leq m_i\leq 2f$); f=fixed wage; j=profit-sharing percentage; p=profit per unit of output; x_i=agent *i*'s output; y_i =average output of agent *i*'s comparison group (i.e., RPI); and q=compensation per unit for the deviation of x_i from the comparison group's average output.

[6] To isolate the direct effects of RPI in a contract, it is necessary for the form of the RPE contract to be identical to that of the non-RPE contract except for the presence or absence of RPI. In addition, Demski and Kreps (1982) recommend that an RPE contract compensate agent *i* on absolute output as well as on the deviation of his or her output in comparison with others. Adding a relative evaluation component to the profit-sharing contract satisfies both criteria.

conomic Hypotheses

Agency theory assumes (1) that agents' utility functions are additively separable in tility from compensation, $U_i(\bullet)$, and disutility from effort, $V_i(a_i)$, (2) that agents are isk- and effort-averse, and (3) that, according to the incentive compatibility contraints, agents select the effort levels that maximize their expected utility for the given haring rule. The economic hypotheses are based on these three assumptions.

If employed under the profit-sharing contract, agent *i* is expected to select the effort evel that maximizes $E\{U_i[f+j(p\bullet x_i)]\}-V_i(a_i)$. Since the comparison group's average erformance (i.e., RPI) does not enter into agents *i*'s objective function, RPI does not ffect agent *i*'s utility from compensation or disutility from effort. Thus, RPI or any hanges in the informativeness of RPI, such as from a change in the degree of common ncertainty, is not expected to affect agent *i*'s effort decision. The hypothesis is that:

H1: With the profit-sharing contract, *ceteris paribus*, increasing the degree of common environmental uncertainty does not affect agents' effort levels.

With the RPE contract, agent *i* is expected to select the effort level that maximizes $\{U_i[f+j(p\bullet x_i)+q(x_i-y_i)]\}-V_i(a_i)$. If the agents possess homogeneous preferences nd beliefs, the relative evaluation component of the RPE contract is a "zero-sum ame" in that, on average, the term (x_i-y_i) should equal zero. Thus, on average, the gent's optimization problem with the RPE contract reduces to $E\{U_i[f+j(p\bullet x_i)]\}-V_i(a_i)$. This implies that the optimal solution is for the agents to act cooperatively and gnore the RPI component.

However, the cooperative solution is not enforceable *ex post*. If agent *i* expects the ther agents to act cooperatively and ignore the RPI component, agent *i* can exert more ffort and earn a bonus. Alternatively, if agent *i* expects the other agents to act noncooperatively and try to earn a bonus by exerting more effort, agent *i* can exert more effort o avoid incurring a penalty. Thus, the potential to earn a bonus or avoid a penalty with he RPE contract induces agents to act competitively and exert more effort than with he cooperative solution, which implies that the optimal competitive effort level for the PE contract is greater than the optimal effort level for the profit-sharing contract. The ypothesis is that:

H2: *Ceteris paribus*, agents' effort levels are higher with the RPE contract than with the profit-sharing contract.

Another question of interest related to the RPE contract is the direct effect on effort f increasing the degree of common uncertainty. Since the cooperative solution is not nforceable *ex post*, the following analysis focuses on the competitive solution. The ptimal competitive solution is to exert effort until the expected marginal cost of xerting effort equals the expected marginal benefit of one unit of effort more than the omparison agents are expected to exert.

As the degree of common uncertainty increases, a source of variation in performance across agents decreases, which implies that the variance of the term $(x_i - y_i)$ decreases (i.e., the informativeness of RPI increases). Thus, increasing the degree of common uncertainty allows RPI to reveal more about the uncertainty agent *i* faces, which increases the amount of uncertainty that can be filtered from agent *i*'s evaluation (Baiman and Demski 1980; Holmstrom 1982; Wolfson 1985). The ability to filter more uncertainty improves risk sharing between the principal and agents, and the principal would be expected to benefit from improved risk sharing through the contract offered to the agents. The principal in this setting, however, is unable to extract the benefits of improved risk sharing because the contract parameters are held constant. Instead, the benefits of improved risk sharing accrue to the agents. It is unclear *a priori*, though, whether the increased utility arising from the improved risk sharing is sufficient to increase the agents' effort levels as the degree of common uncertainty increases.

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[7] Not allowing contract parameters to vary is consistent with instances of prohibitive renegotiation costs. n such cases, it is too costly to renegotiate agent *i*'s contract for changes in the contracting environment.

To determine the effort effects of increasing the degree of common uncertainty, contract parameters, probability distributions, and agents' utility functions were specified, and the optimal effort levels under different levels of common uncertainty were computed (see the appendix). Solving for the optimal effort levels indicated that agents' expected utility from compensation increases as the degree of common uncertainty increases, as predicted, but the curves for marginal utility for compensation and marginal disutility for effort intersect at the same effort level for each level of common uncertainty. Thus, the optimal competitive effort level is invariant to changes in the degree of common uncertainty. The analysis was repeated by using a variety of contract parameters, utility parameters, and a different RPE contract. These sensitivity tests indicate that the result that the optimal effort level is invariant to changes in the degree of common uncertainty is not limited to the contract form, contract parameters, or utility parameters initially selected. In addition, this finding is consistent with Holmstrom's (1982) position that RPE can be used to improve risk sharing without affecting an agent's incentives to exert effort. The hypothesis is that:

> H3: With the RPE contract, *ceteris paribus*, increasing the degree of common environmental uncertainty does not affect agents' effort levels.

Behavioral Hypotheses

Since Triplett (1898) first documented that agents perform at a higher level in the presence of others than when working alone, a great deal of research has focused on the performance effects of social influences. Social influence theories range from the mechanistic to those that are more cognitive-oriented.

Mechanistic theories, such as Zajonc's (1965) social facilitation theory and Cottrell's (1972) evaluation apprehension-arousal theory, posit that social influences induce a drive or arousal in the focal agent, thereby affecting the agent's behavior. Alternatively, cognitive-oriented theories, such as Ferris et al.'s (1978) expectancy theory approach and Festinger's (1954) theory of social comparison, argue "that the presence of others . . . may trigger a variety of cognitive activities that are then related to behavior" (Ferris and Mitchell 1987, 109).

Ferris and Mitchell use the saliency of a social influence to reconcile the mechanistic and cognitive theories. They argue "that the more salient or important the 'other(s),' the more likely the focal [agent] is to engage in cognitive activity and information processing" (1987, 118). At low levels of saliency, such as when other agents are working on different tasks in the same setting (i.e., audience effect), the focal agent is expected to experience low levels of evaluation apprehension and engage in some level of self-monitoring. These two factors may cause the focal agent to increase attention to the task and, depending on the task's complexity, to perform at either a higher or a lower level.

At high levels of saliency, such as when other agents performing the same task provide cues about the appropriate performance level, the focal agent is expected to engage in social learning, social comparisons, and modeling. In addition, social cues may influence the focal agent's expectancies and valences. Thus, a social influence is expected to have a greater effect on cognitive processes as the source of the social influence increases in saliency to the focal agent.

Harkins and Jackson (1985) and Beck and Seta (1980) show that agents' performances must be comparable for RPI to be salient to the agents, and Seta (1982) and Clifford (1971) provide evidence that the similarity of the comparison agents and the saliency of RPI are positively correlated. A factor that affects both the comparability of agents' performances and the similarity of comparison agents is the environmental uncertainty they share. With low common uncertainty, agents' environments are dissimilar and differential performance levels across agents could be attributable to many factors. Increasing the uncertainty shared by the agents increases the comparability of their performances and the similarity of their environments, thereby increasing the saliency of RPI.

The increased saliency of RPI as the degree of common uncertainty increases is expected to result in greater cognitive activity, and "[t]hese cognitive processes are likely to result in the focal [agent] behaving in ways that are similar to the behavior of his or her coworkers, or the *behavior expected by the active cues being sent*" (Ferris and Mitchell 1987, 119; emphasis added).

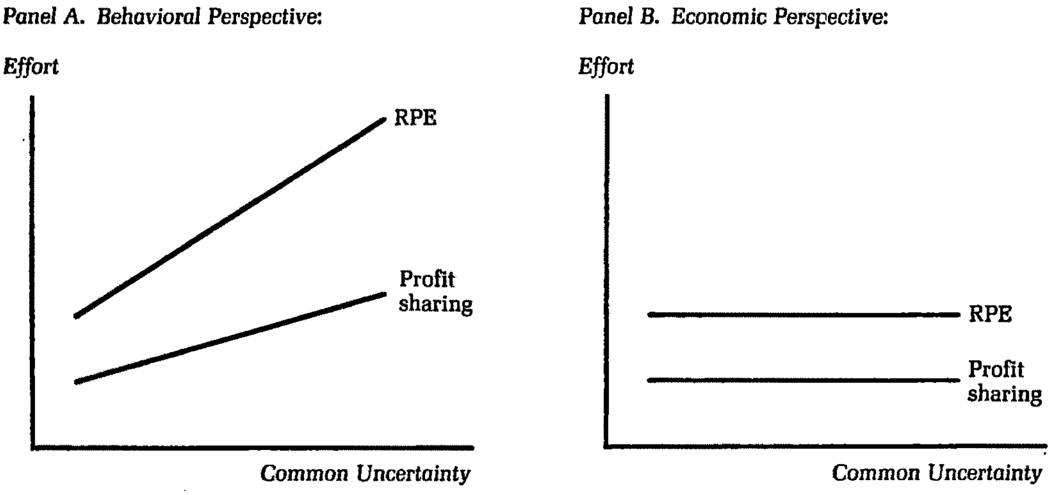
Letting an agent know that RPI will be provided along with feedback about his or her performance suggests to the agent that competing against other agents is appropriate behavior (Beck and Seta 1980; Locke 1968; Seta 1982) because the agent knows that RPI can be used for rivalrous comparisons of performance. Hence, providing agents with RPI provides the cue that competing with one another is the appropriate behavior. Since the saliency of comparisons increases as the degree of common uncertainty increases, competition is expected to increase as the degree of common uncertainty increases. In turn, this increased competition is expected to result in agents exerting more effort. The hypotheses are:

H4: With the profit-sharing contract, *ceteris paribus*, increasing the degree of common environmental uncertainty increases agents' effort levels.

H5: With the RPE contract, *ceteris paribus*, increasing the degree of common environmental uncertainty increases agents' effort levels.

By explicitly offering the potential for a pecuniary reward or penalty from competing against the comparison agents, the RPE contract reinforces the general saliency of the comparison agents that is induced by providing agents with RPI. The importance to an agent of earning (avoiding) the reward (penalty) with the RPE contract causes increased attention to the comparison agents. Alternatively, the profit-sharing contract mitigates the general saliency of the comparison agents because the contract offers pecuniary rewards only for individual performance, not for relative performance. Consequently, the profit-sharing contract suggests to an agent that, although RPI can be

Figure 1
Hypothesized Effects of Contract Type and Degree of Common Uncertainty on Effort



used to make rivalrous comparisons of performance, individual performance is more important than relative performance.

The differential importance of relative performance across the two contracts implies that the comparison agents are more salient to the focal agent with the RPE contract than with the profit-sharing contract. Thus, agents working under the RPE contract are more likely to engage in the behavior suggested by the social cue and, hence, be more competitive and exert more effort than the agents working under the profit-sharing contract. In addition, since the saliency of the comparison agents to the focal agent is greater with the RPE contract than with the profit-sharing contract, changes in the degree of common uncertainty should be more important to the agents working under the RPE contract. Thus, increasing the degree of common uncertainty is expected to have a greater effect on agents' effort levels with the RPE contract than with the profit-sharing contract. The hypotheses are:

H6: *Ceteris paribus*, agents' effort levels are higher with the RPE contract than with the profit-sharing contract.

H7: *Ceteris paribus*, agents' effort levels increase more with the RPE contract than with the profit-sharing contract as the degree of common uncertainty increases.

Summary of Hypotheses

The hypotheses are summaraized graphically in figure 1. Agents' effort levels are expected to be higher with the RPE contract than with the profit-sharing contract regardless of whether one focuses on economic or behavioral factors. However, on the basis of economic factors, increasing the degree of common environmental uncertainty is not expected to affect agents' effort levels with either the profit-sharing or RPE contract. Alternatively, on the basis of behavioral factors, agents are expected to exert more effort under both contracts as the degree of common uncertainty increases, and agents' effort levels are expected to increase more with the RPE contract than with the profit-sharing contract.

II. Experimental Method

Subjects and Design

A laboratory experiment with 36 first-year MBA students was conducted to test the hypotheses.[8] A 2 × 3 factorial design was obtained by crossing two types of contracts (a profit-sharing contract and an RPE contract) with three levels of common environmental uncertainty (low, moderate, and high). Subjects were assigned to one of four experimental sessions according to their availability, and two sessions were assigned to each contract.[9] Every subject was tested under all three levels of common uncertainty (i.e., a within-subjects manipulation).[10]

The experiment consisted of five parts. The first part introduced the experimental exercise, and the second part explained how subjects would be compensated. The third part served as a practice session under the complete set of exercise rules, and the fourth part was the actual experimental session. A questionnaire collecting demographic data and information about experimental manipulations was given in the fifth part.

Overview of Experimental Session

Subjects managed hypothetical production shifts in a computer exercise and were responsible for deciding how many units their shift would produce. Their production decisions were carried out by an automated production process, and the quality of the finished product, either acceptable or unacceptable, was a random event. The terms plant, production line, and production shift were used to facilitate the subjects' understanding of the exercise. There were two plants, and each consisted of five production lines, with three production shifts on each production line (see fig. 2).

The probability of being assigned to either plant was fixed at 50 percent, and the probability of being assigned to a particular production line, given a plant assignment, was fixed at 20 percent. Production followed a binomial distribution in which p (i.e., the expected percentage of acceptable quality units) equaled the probability that a unit produced would be acceptable and $1-p$ equaled the probability that a unit produced

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[8] Employment situations in the real world often result in cohesive work groups in which social norms and group culture are important. Limiting the pool of subjects to first-year MBA students should result in a more socially cohesive group than using subjects from different classes.

[9] The experiment was conducted over two days. On the first day, the profit-sharing (RPE) contract was assigned to the first (second) session. The contract order was reversed on the second day to control for time-of-day effects. Mann-Whitney tests indicated no significant differences in subjects' age, length of work experience, or gender across the two contracts.

[10] A within-subjects manipulation was used because the subtle nature of the manipulation necessitated controlling for individual differences across subjects. Because of the way in which the experimental task was designed and the way in which common uncertainty was manipulated, there were nine different orderings of the manipulation across subjects during the experimental session. The small number of subjects in each order of the treatment effectively precludes testing for an order effect. However, the large number of orderings, coupled with a large number of training and practice rounds, makes it unlikely that the results are driven by an order effect.

Figure 2
Production Hierarchy

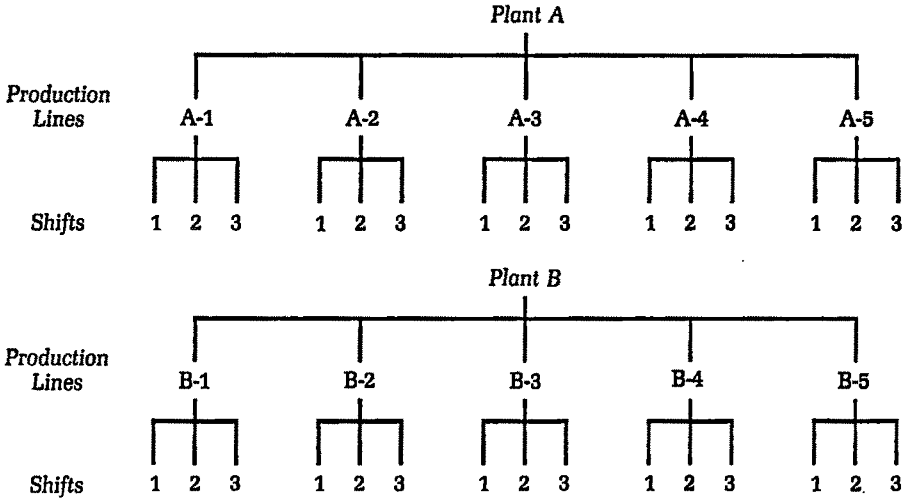

Table 1
Expected Percentage of Acceptable Quality Units

Plant A		*Plant B*	
Production Line	*Expected Percentage of Acceptable Quality Units*	*Production Line*	*Expected Percentage of Acceptable Quality Units*
A-1	10	B-1	50
A-2	20	B-2	60
A-3	30	B-3	70
A-4	40	B-4	80
A-5	50	B-5	90

would not be acceptable. Although p varied across production lines (see table 1), it was constant across the production shifts on a particular production line.

Each experimental session was conducted with nine subjects. At the beginning of each round, the nine subjects were divided into three groups of three (labeled group 1, 2, and 3), with a subject's assigned group serving as his or her comparison group for that round.[11] Three sources of uncertainty affected the number of acceptable quality units each subject produced, and the degree of common uncertainty was manipulated by varying across the three groups the number of sources of uncertainty the group members shared.

[11] The composition of the groups was varied across rounds to control for group-specific strategies. Essentially, each subject faced a new single-period decision each round.

Table 2
Manipulation of Common Environmental Uncertainty

Common Uncertainty	*Plant Assignment of Group Members*	*Production Line Assignment of Group Members*	*Production Outcomes of Group Members*
High (group 1)	Same	Same	Independent
Moderate (group 2)	Same	Independent	Independent
Low (group 3)	Independent	Independent	Independent

The first source of uncertainty was the differential average expected percentage of acceptable quality units in plant A versus plant B (i.e., 30 percent vs. 70 percent). The second source of uncertainty was the different binomial production functions across the production lines in a given plant. As shown in table 1, the expected percentage of acceptable quality units in plant A (plant B) varied from 10 to 50 percent (50 to 90 percent). The final source of uncertainty was the realization of acceptable quality units from the binomial production function for the assigned production line.

The three subjects assigned to group 1 for a particular round shared the first two sources of uncertainty for that round while the three subjects assigned to group 2 (gp. 3) for a particular round shared the first source (no sources) of uncertainty for that round. Thus, groups 1, 2, and 3 represent high, moderate, and low common uncertainty, respectively.

The number of sources of uncertainty that group members shared was manipulated through the process used to assign the members of the groups to production lines. The three subjects in group 1 (i.e., high common uncertainty) were randomly assigned as a group to the same plant and then to the same production line, so these subjects knew that they would be assigned to shifts on the same production line. The three subjects in group 2 (i.e., moderate common uncertainty) were randomly assigned as a group to the same plant, but were individually and randomly assigned to a production line. Thus, these subjects knew they would be assigned to shifts in the same plant, but there was only a 4 percent chance that all three would be assigned to shifts on the same production line. Subjects in group 3 (i.e., low common uncertainty) were individually and randomly assigned to a plant and then individually and randomly assigned to a production line, so these subjects knew there would be only a 25 percent chance that all three of them would be assigned to shifts in the same plant and only a 1 percent chance that all three would be assigned to shifts on the same production line. Since subjects' production decisions were processed independently in all three groups, the outcomes from the production process were independent across the members of a group. The manipulation of common uncertainty is summarized in table 2.

The subjects' task in each round was to decide how many units between 0 and 115 to produce. Before making their decisions, subjects were told which group (i.e., gp. 1, 2, or 3) they had been assigned to for the round. Providing subjects with their group assignments allowed each subject to know the number of sources of uncertainty he or she shared with members of the comparison group, and thereby allowed the manipulation of common uncertainty. To isolate the effects of the manipulation, it was necessary to control for other potentially confounding factors. Since knowledge of the assigned plant or production line would be expected to affect a subject's effort decision independently of the knowlege of the common uncertainty, the effects of these assignments were controlled for by withholding the plant and production line assignments from subjects. In addition, relationships among subjects outside the experimental setting were controlled for by not revealing the identities of the members of the comparison group.

After subjects made their production decisions, the computer "produced" the specified number of units from the appropriate assigned production lines and provided subjects with information about both their individual performance (i.e., number of acceptable units) and the average performance within the comparison group (i.e., RPI). Subjects earned points through their compensation scheme, and they could convert their points into money (discussed below).

Risk and Effort Preferences

According to agency theory (Baiman 1982; Namazi 1985), effort is any action that satisfies three requirements: (1) the agent controls the action, (2) increased action shifts the output distribution to the right, (3) the agent derives disutility from exerting effort. Physical exertion is not a requirement for an action to be considered effort in agency theory.

Effort was measured in this study as the total number of units a subject decided to produce in a round. This measure is consistent with the agency theory definition of effort in that (1) each subject had complete control over the number of units he or she decided to produce and (2) increasing the number of units produced increased the expected number of acceptable quality units. The last requirement was satisfied by inducing disutility for effort through the Berg et al. (1986) technique (discussed below).

The outcome of a task is a joint function of a realized state of nature and an agent's physical skill, mental skill, and effort. Defining effort as the total number of units a subject decided to produce in a round disentangles physical skill and effort (Awasthi 1988). In this study, a subject's number of acceptable quality units (i.e., outcome) is a function of the number of units the subject decides to produce (i.e., effort) and the realization from a stochastic process (i.e., realized state of nature). Hence, the task involves no physical skill.[12]

Risk and effort aversion were induced through the Berg et al. (1986) technique. With this technique, experimental commodities are transformed into the probability of winning a preferred prize via a two-prize lottery, and the transformations induce a preference function for the experimental commodities.[13]

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[12] One could argue that the task requires mental skill in that a subject must possess the ability to process information in a complex task, and mental effort in that a subject must commit cognitive resources to thinking about how many units to produce. However, there is no theoretical reason to expect basic mental skills to have a systematic effect on performance across experimental manipulations. In addition, the mental effort required in this task does not necessarily satisfy the agency theory definition of effort since it is not clear that simply thinking harder or longer about how many units to produce would actually affect how many units a subject would produce. Finally, the experimental design should control for any potential systematic bias due to mental skill or mental effort. One would not expect mental skill or mental effort to vary systematically (1) across the within-subjects manipulation because subjects act as their own control or (2) across the between-subjects manipulation since subjects were randomly assigned to experimental conditions.

[13] In the experiment, the two-prize lottery was presented on a prize wheel, and transforming the experimental commodities into degrees on the prize wheel is equivalent to transforming the experimental commodities into the probability of winning the preferred prize.

In conformance with Holmstrom's (1982) model, agents' utility functions were assumed to be additively separable in compensation and effort. Based on the assumption of additive separability, the probability of winning the preferred prize was determined in two steps. First, utility for compensation was induced. Subjects earned points through their contracts, and these compensation points were transformed into degrees through the function $402.41414 - 402.41414e^{(-0.0125 \cdot \text{points})}$. This transformation is consistent with the agency theory assumption that agents have diminishing marginal utility for compensation.

Second, disutility for effort was induced. The number of units a subject decided to produce, N, was transformed into degrees through the function $10[(N/35)^3]$. Deducting the degrees associated with effort from the degrees associated with compensation induced marginally increasing disutility for effort that was additively separable from the utility for compensation. Thus, a subject's total degrees (i.e., induced utility function) equaled $\{402.41414 - 402.41414e^{(-0.0125 \cdot \text{points})} - 10[(N/35)^3]\}$.[14] The win area on the prize wheel was the area from zero degrees, moving clockwise, to the subject's total degrees. When the wheel's spinner stopped in the win area, the subject received $1.25; otherwise, he or she received $0.75.

Administration of Experiment

Ten participants were required for each of the four experimental sessions, and one of the ten participants was randomly selected to act as the principal.[15] The nine remaining participants were the subjects of interest and acted as managers. The experiment had five parts, which are detailed below.

Part 1. The experimenter randomly distributed instruction packets to the subjects. Each packet contained a code number, which was the only way subjects were identified to the experimenter, to the principal, and to each other. This provided controls for the effects of social pressure (Young 1985) and for relationships among the subjects outside the experimental setting. However, by making the subjects anonymous through codes, the codes may have lessened the behavioral importance of RPI and the competition it can induce.

After distributing the instructions, the experimenter explained the company's production facilities, the subjects' duties, and the production shift assignment process (i.e., common uncertainty manipulation). The subjects then practiced the exercise for six rounds. At the beginning of each round, subjects learned the group assignments for each subject and the plant and production line assignments for each member of their comparison group.[16] Subjects were also told that the principal would not receive any information about their performance during this session since it was only a practice session.

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[14] The primary considerations in selecting the functions of utility for compensation and disutility for effort were that the functions (1) be consistent with the assumptions of agency theory; (2) result in a manageable, uncluttered prize wheel (i.e., one without too many points, which would make it difficult for subjects to understand); (3) not be too extreme (i.e., too steep or too flat); and (4) result in an expected theoretical effort level (based on economic factors) that was approximately in the middle of the potential range of effort levels. This last requirement was necessary to allow subjects sufficient freedom to deviate from the economically optimal effort level because of behavioral factors. Although there is an almost infinite number of functions that would satisfy these requirements, there is no reason to expect that one particular set would be better than another. Further, as discussed in section I, the result that effort level is invariant to changes in the degree of common uncertainty is not unique to the functions used in the experiment.

[15] This study examines the role of RPI and RPE in addressing moral hazard. Since moral hazard requires both a principal and an agent, it was necessary to have someone play the role of the principal. Having a participant act as the principal increased the believability of the situation and the importance of the principal to the subjects. The participant who was randomly selected to be the principal was taken to a different room and asked to participate in a task that was seemingly related to the experiment. After completing the task, this person was paid $7.50 and dismissed. Subjects were led to believe that the principal was receiving information about their performance at specific points in the experiment.

Part 2. The experimenter introduced and demonstrated the assigned contract (i.e., RPE or profit sharing). Subjects practiced the task for six rounds and earned points based on their performance under their assigned contract, but subjects did not have the opportunity to convert their points into money during this session. At the beginning of each round, subjects were told their group assignments for the round, but were not told who the members of their comparison group were or to which plant or production line they and the other members of their group had been assigned. Subjects were again told that the principal would not receive any information about their performance during this session.

Following the practice session, the experimenter introduced and demonstrated the prize wheel and provided charts and figures for converting points and production into degrees. To insure that subjects understood the mechanics of the prize wheel, subjects played four lotteries with the prize wheel for the same prizes used in the experiment.[17]

Part 3. During this stage, subjects performed the exercise for seven rounds under the complete set of exercise rules. They earned points in each round according to their assigned contract and converted their points into money via the prize wheel in the last four rounds.[18] Subjects were also told that part 3 was a work stage and that the principal (1) knew the mechanics of the production shift assignment process and the expected percentage of acceptable quality units on each production line, (2) did not have access to any subject's production line assignment or actual production decision, (3) would receive information about their performance, and (4) would receive the residual from the agency relation.

Part 4. The procedures in this part were identical to those in part 3 and are summarized in table 3. The subjects performed the exercise twice under each level of common uncertainty, for a total of six rounds, and they converted their points into money at the end of each round.[19] To determine whether subjects understood how points and production affected their payoffs, two post-experiment lotteries were played for money with the prize wheel; these lottery questions were similar to those asked at the end of part 2.

Part 5. Subjects were given a questionnaire to complete. Part 1 collected demo-

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[16] The subjects were provided with more detailed information about the group, plant, and production line assignments in part 1 than in other parts of the experiment to reinforce their understanding of the production shift assignment process.

[17] In the lottery questions, subjects were asked to select one of three options that they would actually play on the prize wheel for money. One question asked, "Which of the following choices would you like to play? (1) A 50 percent probability of earning 160 points and a 50 percent probability of earning 0 points. (2) Earning 80 points for sure. (3) I am indifferent between the two choices." Another asked, "Which of the following choices would you like to play? (1) Producing 60 chips and having a 50 percent probability of earning 140 points and a 50 percent probability of earning 0 points. (2) Producing 75 chips and earning 80 points for sure. (3) I am indifferent between the two choices." The other lottery questions were similar.

[18] Participants in the pilot study indicated that they would have liked some practice rounds with no money involved under the complete set of exercise rules. Consequently, it was decided not to allow subjects to convert their points into money in the first three rounds of part 3.

[19] To prevent end-of-period strategies, subjects were told that part 4 would last between four and ten rounds.

Table 3

Summary of Experimental Procedure for Each Round

1. Each subject was assigned to a group (1, 2, or 3) and informed of the assignment.
2. Each subject was assigned to a plant and production line in accordance with his or her group assignment, but was not told these assignments.
3. Each subject was asked to specify how many acceptable quality units he or she was committed to producing.
4. Each subject decided his or her shift's production level (N).
5. The computer produced N units from the assigned production line.
6. The computer generated a production report that included the number of acceptable quality units, the average number of acceptable quality units generated by the subject's comparison group, the subject's compensation (in points), and the subject's total degrees.
7. Each subject converted his or her total degrees into money via the prize wheel.

graphic data and part 2 contained manipulation checks. Subjects were also paid the cash they had earned during the experiment. The mean (standard deviation) winnings for the subjects assigned to the RPE and profit-sharing contracts were \$16.05 (\$1.16) and \$17.63 (\$0.90), respectively.[20]

III. Analysis and Results

Preliminary Analysis

Six subjects, three from each contract, were excluded from the analysis because their answers to the two post-experiment lotteries and the two questions about the prize wheel indicated that they did not understand the prize wheel. Consequently, the remaining analysis is based on the responses of 30 subjects.[21]

To determine whether the experimental manipulations were successful and how the manipulations affected their competitiveness, subjects were asked to indicate their agreement with several statements about the experiment (see table 4). For each statement, subjects marked their agreement on a seven-point scale that ranged from 1, "strongly disagree," to 4, "neutral," to 7, "strongly agree."

The results of the common uncertainty manipulation check (i.e., qu. 1) indicate that, as expected, the mean responses of both contract groups are significantly less than "neutral" (RPE: one-tail $p=0.000$; profit sharing: one-tail $p<0.001$) and that the two groups did not differ significantly in their perception of the manipulation (two-tail $p<0.116$). The responses of the subjects to the contract manipulation check (i.e., qu. 2) indicate that, as expected, the two groups perceived that the contracts provided

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[20] As discussed in section I, the expected long-term compensation (in points) is equal across the RPE and profit-sharing contracts. In addition, the same transformation was used for both contracts to convert points earned into degrees, and subjects working under the two contracts faced the same stochastic process (i.e., the prize wheel). Consequently, any differences in effort levels across the two contracts should not be caused by different expected monetary payoffs as a result of compensation in points.

[21] Two subjects, one from each contract, who were judged to have understood the prize wheel would have been dropped from the analysis of results if a slightly more rigorous set of criteria had been used. The tests of the hypotheses reported in this section were repeated without these two subjects, and the results were qualitatively similar to those reported. In addition, the tests were repeated with all 36 subjects, and these results were also qualitatively similar to those reported.

Table 4
Mean Responses for Manipulation Checks

	Mean Response (s.d.)		Difference Test	
	Profit Contract	*RPE Contract*	*t-statistic*	*p-value*
1. I was more likely to be managing a shift on the same production line as the other members of my group when I was assigned to Group 3 than when I was assigned to Group 1.	2.507 (1.584)	1.667 (1.234)	1.620	0.116
2. My contract provided no incentive to produce more acceptable quality units than my group's average number of acceptable quality units.	5.833 (1.358)	3.467 (1.642)	4.302	0.000
3. I wanted to produce more acceptable quality units than my group's average number of acceptable quality units.	3.583 (1.972)	4.767 (1.613)	1.799	0.042
4. It was important to me to do better than my group's average number of acceptable quality units.	3.633 (1.757)	4.517 (1.407)	1.442	0.080
5. I was more likely to compete with the other people in my group when I was assigned to Group 1 than when I was assigned to Group 3.	3.300 (1.533)	4.800 (1.971)	2.326	0.014

Note: All tests are one-tailed except that for statement 1, which is two-tailed.

different incentives (one-tail $p=0.000$). Thus, the two experimental manipulations appear to have been successful.

The responses to questions 3 and 4 indicate that the RPE contract induced more competitiveness than did the profit-sharing contract. In addition, the responses to question 5 indicate that increasing the degree of common uncertainty had a greater effect on the likelihood to compete for the subjects assigned to the RPE contract than for those assigned to the profit-sharing contract.[22] These findings are consistent with subjects being affected by behavioral, but not economic, factors.

Descriptive Analysis

Subjects' effort levels increased with both contracts as the degree of common uncertainty increased. In addition, the effort levels with the RPE contract were consistently greater than with the profit-sharing contract, with the difference between the two contracts increasing slightly as common uncertainty increased. The results are summarized graphically in figure 3.

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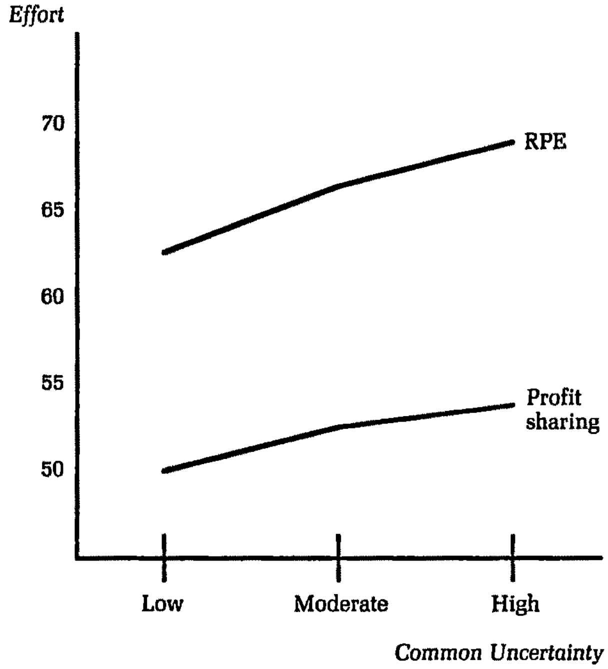
[22] The higher competitiveness with the RPE contract is not attributable to more competitiveness in general among those subjects assigned to the RPE contract. Subjects were asked to rate their general competitiveness on a five-point scale, with 1 being "uncompetitive" and 5 being "very competitive." The Mann-Whitney test indicates that the null hypothesis of no difference between the two contract groups in general competitiveness cannot be rejected (RPE: 3.85; profit sharing: 3.55; two-tail $p>0.14$).

Figure 3
Summary of Results



An interesting statistic is the trend of subjects' effort as the degree of common uncertainty increased. A subject's effort level could have (1) increased as common uncertainty increased, (2) decreased as common uncertainty increased, (3) remained constant as common uncertainty increased, (4) first decreased as common uncertainty increased from low to moderate and then increased as common uncertainty increased from moderate to high (i.e., a *U*-shaped trend), or (5) first increased as common uncertainty increased from low to moderate and then decreased as common uncertainty increased from moderate to high (i.e., an inverted *U*-shaped trend). On the basis of behavioral factors, one would expect all subjects to exhibit an increasing trend; on the basis of economic factors, a constant trend would be expected.

As table 5 indicates, a majority of the subjects did increase their effort as the degree of common uncertainty increased, but some subjects exhibited nonincreasing trends, and the pattern of trends was different across the two contracts (i.e., the pattern under the profit-sharing contract appears to be more random). These results provide some support for the importance of behavioral factors and also indicate that contract type may affect the relative importance of behavioral and economic factors as determinants of behavior.

Testing of Hypotheses

The hypotheses address the direct effects on effort that result from (1) degree of common uncertainty, (2) contract type, and (3) the interaction between contract type

Table 5
Trend of Subjects' Effort Decisions as Degree of Common Uncertainty Increased

	RPE Contract		*Profit-Sharing Contract*	
Trend	*Number*	*Percentage*	*Number*	*Percentage*
Increase	9	60.00	7	46.67
Constant	3	20.00	2	13.33
Decrease	1	6.67	3	20.00
U-shaped	1	6.67	2	13.33
Inverted U-shaped	1	6.67	1	6.67
Total	15	100.00	15	100.00

and degree of common uncertainty. The dependent variables used to test the hypotheses are each subject's average effort level for a given degree of common uncertainty (i.e., average effort level under low, moderate, and high common uncertainty). Thus, there are three dependent variables for each subject. The cell means are summarized in table 6.

Degree of Common Uncertainty. Hypothesis 1 is based on economic factors and predicts that increasing the degree of common uncertainty does not affect agents' effort levels with the profit-sharing contract. Hypothesis 3 is the same except that the prediction is for the RPE contract. Alternatively, hypothesis 4 is based on behavioral factors and predicts that increasing the degree of common uncertainty increases agents' effort levels with the profit-sharing contract, and hypothesis 5 is the same except that the prediction is for the RPE contract.

Since the hypotheses are contract-specific, the data are partitioned by contract type, and each contract subsample is analyzed separately. The data do not satisfy the conditions for using univariate, repeated measures analysis of variance (discussed in fn. 24), so each subsample is analyzed with multivariate analysis of variance (MANOVA), which yields exact F-statistics. The null hypothesis of equal cell means can be rejected with the RPE contract ($F_{df=2,13}=3.722$, two-tail $p<0.053$), but not with the profit-sharing contract ($F_{df=2,13}=0.753$, two-tail $p<0.491$). Thus, hypotheses 1 and 5 are supported, but hypotheses 3 and 4 are not.[23]

Although the MANOVAs test whether the treatment means are equal, they do not provide direct tests of hypotheses 1 and 4, which predict a monotonic relation between the degree of common uncertainty and effort (i.e., $\text{Effort}_{\text{Low}}<\text{Effort}_{\text{Moderate}}<\text{Effort}_{\text{High}}$). Marascuilo and Serlin (1988) present a procedure that involves a contrast of the treatment means for testing for the presence of a monotonic trend.[24] The null hypothesis

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[23] The null hypothesis tested in a one-way MANOVA is that the treatment means are equal. Since hypothesis 1 is equivalent to this null hypothesis, rejection of the null hypothesis would not support hypothesis 1 but failure to reject it would provide weak support. The same holds for hypothesis 3.

[24] The procedure described by Marascuilo and Serlin is based on ANOVA. For a split-plot ANOVA to yield valid significance levels for a test involving a within-subjects treatment, the k within-subjects treatments must have equal variances and the $[k(k-1)]/2$ pairwise correlations must be equal (Geisser and Greenhouse 1958;

Table 6
Summary of Effort Levels by Cell

	Degree of Common Uncertainty			
	Low	*Moderate*	*High*	*Average*
RPE contract	62.400	66.067	68.733	65.733
Profit-sharing contract	50.067	52.633	53.733	52.144
Average	56.233	59.350	61.233	58.939

that the treatment means of 62.400, 66.067, and 68.733 in the RPE subsample do not follow a monotonic trend can be rejected ($t_{df=28}=2.877$, one-tail $p<0.007$), but the null hypothesis that the treatment means of 50.067, 52.633, and 53.733 in the profit-sharing subsample do not follow a monotonic trend cannot be rejected ($t_{df=28}=1.195$, one-tail $p<0.130$). The Page test, a nonparametric test for ordered alternatives, yielded qualitatively similar results. Thus, additional support is provided for hypothesis 5.

Contract Type. Hypotheses 2 and 6, which are based on economic and behavioral factors, respectively, both predict that agents' effort levels are higher under the RPE contract than under the profit-sharing contract. The mean effort level of 65.733 under the RPE contract and 52.144 under the profit-sharing contract are significantly different ($t_{df=28}=2.04$, one-tail $p<0.026$). Thus, hypotheses 2 and 6 are supported.

Interaction Effect. Hypothesis 7 predicts that agents' effort levels increase more with the RPE contract than with the profit-sharing contract as common uncertainty increases. The results of a two-way MANOVA indicate that the interaction between contract type and degree of common uncertainty is not significant ($F_{df=2,27}=0.132$, two-tail $p<0.877$). Thus, hypothesis 7 is not supported.

IV. Discussion

This study examines the direct effects of contract type and degree of common uncertainty on effort when agents know that they and the principal will receive RPI. Effort was higher under the RPE contract than under the profit-sharing contract, which is consistent with the importance of economic and behavioral factors as determinants of behavior. However, the results involving degree of common uncertainty are mixed in that support for the importance of economic and behavioral factors depends on the contract type examined. Effort increased significantly as common uncertainty increased with the RPE contract, which is consistent with behavioral factors having incremental explanatory power over economic factors, but effort did not increase sig-

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Huynh and Feldt 1976; Kirk 1968). If these assumptions are not met, the degrees of freedom associated with the resulting F-ratio are overstated, which leads to overstated significance levels. Geisser and Greenhouse (1958) show that the *maximum* necessary reduction in degrees of freedom is obtained by dividing the degrees of freedom in the numerator and denominator of the F-ratio by the degrees of freedom associated with the within-subjects treatment (i.e., $k-1$). Since the null hypotheses of equal variances and equal correlations can be rejected for both the RPE subsample (two-tail $p<0.001$) and the profit-sharing subsample (two-tail $p<0.001$), the significance levels reported are adjusted via the Giesser and Greenhouse technique and so are conservative.

nificantly with the profit-sharing contract, which is consistent with economic factors dominating behavioral factors. Although the effect of common uncertainty varied across the two contracts, the interaction between contract type and degree of common uncertainty is not significant.

The seemingly disparate results across contract type suggest two things. First, behavioral factors can be important in motivating effort because a behavioral, but no economic, reason exists for effort to increase with the RPE contract as common uncertainty increases. Second, although the interaction between contract type and common uncertainty is not significant, there is some weak evidence that economic factors can enhance or mitigate the importance of behavioral factors. Specifically, the post-experiment questionnaire revealed that the RPE contract caused subjects to be more competitive and more likely to compete than the subjects assigned to the profit-sharing contract.

These conclusions have at least two implications for future accounting research. First, researchers constructing economic models must be cognizant of the importance of behavioral factors in motivating effort and of how economic factors may interact with behavioral factors. Further, conclusions drawn from formal economic models that ignore behavioral factors should be interpreted cautiously. Second, researchers conducting an experiment based on a formal economic model should consider relevant behavioral factors as well as the underlying economic model when designing the experiment. Failure to consider behavioral factors could lower the study's internal validity, which could lead to inappropriate conclusions when economic and behavioral factors result in similar predictions but for different reasons. Behavioral factors may also explain empirical results that are anomalous given an economic model. Similarly, researchers conducting experiments based on behavioral models should consider the effects of economic factors.

Several aspects of the study are worth noting. First, explicitly including both behavioral and economic factors increases the study's internal validity. If the study had relied solely on either behavioral or economic factors, one could argue that the results could be explained by omitted factors. In addition, since tests of behavioral factors in studies of organizational behavior usually ignore economic factors, testing behavioral factors in an economic environment (i.e., considering risk and effort preferences and incentive compensation) provides a more stringent test of these factors than has been typical.

Second, the focus of this study is on the *direct* effects of contract type and degree of common uncertainty on effort in an RPI environment. Before one can test and interpret the indirect effects from adjusting contracts to reflect changes in the contracting environment, one must understand the effects that are independent of such adjustments. Thus, from this perspective, not allowing contract parameters to vary as the degree of common uncertainty increased is crucial.

Third, several experimental design decisions may have mitigated the importance of the behavioral factors, and biased against the behavioral hypotheses. For example, the decision to assign subjects a code number, which was the only way subjects were identifiable to each other, controlled for relationships among subjects outside of the experimental setting. However, this control may have decreased the behavioral importance of RPI because relationships among agents may affect their decision on whether to compete with one another.

Fourth, subjects' risk and effort preferences were induced. Selto and Cooper (1990) reviewed and evaluated alternative methods for controlling risk attitudes in experimental accounting research. They concluded that complex tasks, such as the one in this study, "may impede risk attitude inducement" (1990, 240). Thus, the lack of support for economic factors obtained in this study may be, at least partially, attributable to subjects not accepting the induced utility functions. If so, subjects would not have had the risk preferences assumed in the underlying economic model. However, attempts to assess whether subjects understood the induced utility process (1) through post-experimental manipulation checks, as suggested by Selto and Cooper, and (2) by having subjects play binary lotteries for the same dollar prizes possible in the actual experiment seem to indicate that subjects did understand the inducement process. It is not possible though to know for certain whether the utility functions were successfully induced during the actual experiment.

Agency theory has been criticized for focusing too heavily on single-agent environments (Baiman 1982; Demski and Kreps 1982) because most organizations employ multiple agents. Thus, additional analytical and empirical research that examines multi-agent environments appears to be a more relevant and fruitful approach for studying motivation than focusing on single-agent environments. For example, empirical research that examines the indirect effects of RPE on effort may be useful. Analytical research on RPE has studied its effects on both risk taking and effort. Chow and Haddad (1991) empirically studied the risk-taking effects of RPE, and the current study empirically examines the effects of RPE on effort. Future empirical research that examines these effects jointly is needed. In addition, more research is needed that explicitly considers the dual effects of economic and behavioral factors in motivating effort.

Appendix

Optimal Effort Levels

The optimal solution for both contracts was determined by equating the marginal benefit and cost of effort. The following contract and utility parameters were used in the experiment.

RPE contract: $m_i = 90 + 10\%(20 \bullet x_i) + 4(x_i - y_i)$, where $y_i = [(x_i + x_j + x_k) \div 3]$.
Profit-sharing contract: $m_i = 90 + 10\%(20 \bullet x_i)$.
Utility from compensation: $402.41414 - 402.41414e^{-0.0125m_i}$.
Disutility for effort: $10[(a_i/35)^3]$, where a_i equals agent i's effort.

Marginal Benefit: RPE Contract

Deduct the expected utility for the compensation associated with a_i, where agents i, j, and k are assumed to all exert the same level of effort (i.e., $a_i = a_j = a_k$), from the expected utility for the compensation associated with $a_i + 1$, where agent i is assumed to exert one unit of effort more than agents j and k (i.e., $a_i = a_j + 1 = a_k + 1$), $a_i = 0, 1, \ldots, 115$.

Marginal Benefit: Profit-Sharing Contract

Deduct the expected utility from compensation for a_i from the expected utility from compensation for $a_i + 1$, $a_i = 0, 1, \ldots, 115$.

Marginal Cost

Deduct the expected disutility of effort for a_i from the expected disutility of effort for $a_i + 1$, $a_i = 0, 1, \ldots, 115$.

The optimal solution under the RPE (profit-sharing) contract was to produce 47 (37) units regardless of the level of common uncertainty. The analysis was repeated by using different contract and utility parameters and an RPE contract of the form $m_i = f + q(x_i - y_i)$. These sensitivity tests indicate that the result—an optimal effort level invariant to changes in the degree of common uncertainty—is not unique to the contract form, contract parameters, or utility parameters selected. However, it should be noted that, although unchanging for a given combination of contract form, contract parameters, and utility parameters, the optimal effort level did vary as the combination of contract form, contract parameters, and utility parameters was varied.

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A FORUM ON
ACCOUNTING FOR DEFENSE CONTRACTS

1. William P. Rogerson
   Overhead Allocation and Incentives for Cost Minimization in Defense Procurement

2. Jacob K. Thomas and Samuel Tung
   Cost Manipulation Incentives Under Cost Reimbursement: Pension Costs for Defense Contracts

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5. Frank R. Lichtenberg
   A Perspective on Accounting for Defense Contracts

Editor's Note: A "Forum" is a collection of articles around a common theme. Accepted refereed articles are followed by an invited "perspective" authored by experts on that theme. In addition to allowing for synergy and to providing alternative explanations for the results, an objective of the "perspective" is to provide guidance for future research on issues related to that common theme.

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Overhead Allocation and Incentives for Cost Minimization in Defense Procurement

William P. Rogerson
Northwestern University

SYNOPSIS AND INTRODUCTION: Defense firms typically produce a large number of products. The purpose of this article is to explain how two features of the current regulatory process create a significant incentive for these multiple-product firms to choose inefficient production methods.

The first feature is that the marginal impact of accounting cost on price varies significantly among products. Prices for a defense firm's products are set according to a rather unique process that combines elements of both competition and cost-based regulation. Defense firms typically produce some purely commercial products and prices for these products are competitively determined. Aside from standard off-the-shelf items such as army boots, most defense products are purchased from a sole source and thus their prices are nominally cost-based. In reality, the negotiated price is likely to be affected by other factors as well. In particular, in cases where closer substitutes exist or where an alternative source might not be prohibitively expensive, the potential cost of these alternatives plays a role. The important consequence of this is that the negotiated price will not necessarily decline or rise by a full dollar when the projected cost of production declines or rises by a dollar. In more competitive procurements where the cost of alternatives plays a stronger role, changes in projected accounting cost are less important.

The second feature of the regulatory process concerns the method that defense firms are allowed to use to calculate the cost of each product. Following traditional commercial accounting practices, only a relatively small fraction of costs are directly charged to products. The remaining costs are grouped together into overhead pools and allocated across products usually in proportion to directly charged labor use.

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These two features create the following incentive problem. Given the first feature, the firm would like to be able to assign more of its costs to well-funded sole source procurements instead of to more competitive procurements or commercial products. The second feature provides a method for accomplishing this task. Namely, the firm can increase (decrease) the amount of overhead allocated to a contract by increasing (decreasing) the amount of direct labor used on the contract.

This means that the firm will have an incentive to engage in pure waste by padding direct labor usage on contracts with cost sensitive revenues. It will also have the incentive to distort its input substitution decisions between labor and other inputs by using too much (too little) direct labor on contracts with cost sensitive (cost insensitive) revenues. Two major types of input substitutes for labor exist. The first is capital. Thus, we would expect the firm to purposely under-capitalize production of products with cost sensitive revenues and over-capitalize production of products with cost insensitive revenues. The second possible input substitute is material. For many subcomponents of a weapon, a firm has the potential option of subcontracting production to another firm or making the component in-house. Subcontracting will result in higher direct material costs for the firm but lower direct labor costs. Thus, engaging in more in-house production is essentially a way of substituting towards direct labor and away from direct material. In particular, then, we would expect the firm to purposely engage in too much in-house production for its products with cost sensitive revenue and too much subcontracting for its products with cost insensitive revenue.

An important point to note about this incentive effect is that it does not require the firm to report any cost projections untruthfully. That is, in the behavior predicted by this article, the firm does *not* make money by projecting that costs will be high (in order to get a high price) and then actually having low costs. The firm actually spends all of the money that is charged as a cost. The profit occurs through shifting the assignment of these costs. The importance of this point is that auditing is very poorly equipped to deal with this type of behavior. Auditing is relatively good at determining whether the firm actually spent as much as it projected. However, it is relatively poor at determining whether any expenditure that actually occurred was necessary.

Braeutigam and Panzar (1989), Brennan (1990), and Sweeney (1982) have analyzed models of public utility regulation where the utility has commercial business segments. They make the general point that, depending upon how costs are allocated, the firm may have an incentive to distort its output and/or input decisions in order to shift overhead to the regulated sector. However, none of these articles analyzes allocation schemes based on direct labor or any other input base. Braeutigam and Panzar (1989) and Sweeney (1982) consider allocation schemes based on units of output under the assumption that comparable units of output exist across different products. Brennan (1990) considers allocation schemes where each product is allocated a fixed, invariant share of overhead. Thus all of the predictions of this article regarding the particular sorts of input distortions

one would expect to see in defense procurement are new to this article. Furthermore, on a technical level, the model of this article is also somewhat different because it considers a multiple product case where products are not necessarily either perfectly competitive or perfectly regulated and the level of competitiveness varies from product to product.

Key Words: *Cost allocation, Costing manipulation, Defense procurement.*

THE organization of this article is as follows. Section I presents the formal model. The formal analysis begins in section II with the calculation of the marginal effect on profit of various input distortions. The analysis is completed in section III with the calculation of equilibrium input distortions. In section IV, I attempt to assess the empirical significance of these incentive effects by actually estimating the marginal effect of input distortions on profit for a typical defense firm. The results and possible policy approaches are discussed in section V.

I. The Model

First, I will describe how revenues are determined given the vector of fully allocated costs. Then I will describe how the vector of fully allocated costs is determined by the accounting system of the firm.

Revenues

Suppose that the firm is producing n products, indexed by $i \in \{1,\ldots,n\}$. Some of these products are sold to the Department of Defense (DOD) and others may be purely commercial. For expositional simplicity it will be assumed that a fixed quantity of each product is produced.

Let C_i denote the fully allocated cost of product i. Since the incentive effect identified in this article does not require the firm to be able to truthfully project cost or for there to be uncertainty, it will be assumed that the DOD knows C_i and that it is nonstochastic. Assume that the revenue from each product is determined by some twice continuously differentiable function, $\phi_i(C_i)$, where $0 \leq \phi_i'(C_i) \leq 1$. The left hand inequality simply requires that revenue be weakly increasing in accounting cost and the right hand inequality rules out cost plus a percentage of cost (CPPC) pricing. The firm would face obvious incentives to increase cost if there were CPPC pricing. The point of this paper is to show that an incentive to increase cost exists even when there is no CPPC pricing.

The derivative of revenue with respect to cost, $\phi_i'(C_i)$, is a measure of the cost sensitivity of the revenue of product i. The basic explanation of why $\phi_i'(C_i)$ varies among products was presented in the introduction. Although the regulations nominally require that price be set exactly equal to anticipated cost, in reality the relative bargaining strength of the two parties also affects price. In particular, cost will become less important when the procurement is more competitive.

Two types of competitive pressures exist. Intracontract competition occurs when a number of firms are competing for the same contract. The term sole source (multiple source) will be used to describe contracts facing low (high) levels of intracontract competition. Intercontract competition, which occurs when a given contract must compete for funding with other possible uses of the funds, can exist at many different levels. For example, two weapons systems might be viewed as substitutes for performing the same narrowly defined military mission. Alternatively, two weapons systems performing very different missions might be viewed as substitutes in producing defense. At the broadest level, defense and non-defense programs substitute in producing social welfare. Strong intercontract competition at any of the above levels will manifest itself in the form of tight budgets and funding constraints. Thus, the term well-funded (poorly funded) will be used to describe contracts facing low (high) levels of intercontract competition.

For expositional convenience, the above discussion has been cast as though all contracts were fixed price. However, the modelling assumption that revenues are a function of accounting costs is also appropriate to describe the situation occurring under cost type contracts. An important point to note in interpreting this model is that the strength of competition rather than contract type will be the primary determinant of a contract's cost sensitivity. In particular, cost type contracts will not necessarily be more cost sensitive than fixed price type contracts. A cost reimbursement contract explicitly requires that *ex post* revenues move on a dollar-for-dollar basis with *ex post* costs. However, it also includes a clause specifying the maximum amount of cost the firm can incur and be reimbursed for. In many cases, defense firms purposely accept cost type contracts which are not funded (and will not be funded) up to the level of the expenditures they truly expect to incur. In these cases, the marginal effect of cost changes on revenue may well be less than 1, and perhaps even equal to zero. This is because *ex ante* negotiations over the ceiling level and *ex post* negotiations over incremental funding for overruns will determine the firm's revenues.[1]

Fully Allocated Costs

To illustrate the effects of the firm's cost-accounting system in the simplest possible model, it will be assumed that all overhead is allocated in proportion to direct labor usage. To the extent that overhead is allocated according to direct labor, the effects identified in this article will continue to exist in more complex environments with multiple overhead pools and where not all overhead is necessarily allocated according to direct labor.

The cost-accounting system directly assigns some labor and material to individual contracts. Let L_i and M_i denote, respectively, the dollar value of direct labor and direct material for contract i. All other inputs are called indirect cost or overhead. Let V denote the total dollar value of overhead. Assume that some of the overhead costs are incurred for one and only one product. These costs are not directly assigned to contracts because it would be expensive or perhaps impossible to do so objectively. Let Z_i denote the costs for product i that are included in overhead. Finally, let J denote joint costs, such as many capital costs, that cannot be assigned to any particular contract even in principle. Total overhead is the sum of these components.

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[1] For example, as explained in Rogerson (1989), defense firms as a standard operating procedure lose money on cost type R&D contracts in the early stages of a program in order to be selected as the sole producer of the weapon and (hopefully) earn large profits when negotiating fixed price production contracts in a sole source environment.

$$V=\sum_{i=1}^{n} Z_i+J. \tag{1}$$

Overhead is allocated to contracts in proportion to direct labor usage. The overhead allocated to product i, denoted by V_i, is given by:

$$V_i=\frac{L_i V}{\left(\sum_{k=1}^{n} L_k\right)}. \tag{2}$$

Let R^M denote the overhead rate, which is the ratio of overhead to direct labor.

$$R^M=\frac{V}{\sum_{k=1}^{n} L_k}, \tag{3}$$

We can view each dollar of direct labor as attracting R^M dollars of overhead. Consistent with intuition, equation (2) can be rewritten as:

$$V_i=R^M L_i. \tag{4}$$

The total cost of product i, denoted by C_i, is the sum of all direct and indirect costs and is given by:

$$C_i=L_i+M_i+\left(\frac{L_i}{\sum_{k=1}^{n} L_k}\right)\left(\sum_{k=1}^{n} Z_k+J\right), \tag{5}$$

or, equivalently, by:

$$C_i=(1+R^M)L_i+M_i. \tag{6}$$

Finally, it will be useful to let a variable without the subscript i denote the vector of corresponding variables for each product, that is, $C=(C_1,\ldots,C_n)$, $L=(L_1,\ldots,L_n)$, and so on.

II. Formal Analysis: The Marginal Effect of Input Choice on Profit

The firm's profit, given its input choices, is given by the function:

$$\Gamma(L,M,Z,J)=\sum_{j=1}^{n} \phi_j(C_j)-C_j, \tag{7}$$

where C_j is determined by equation (5). I will actually solve for the profit maximizing input choices of the firm in the next section, but will calculate the marginal effect on profit from various types of waste or input substitutions here. This will provide an explanation of the cause and nature of the incentive effects acting on the firm. Also, the formulas developed here will provide a useful method for calculating the magnitude of the incentive effects that actually exist.

The Fundamental Result

Let A denote the weighted average cost sensitivity of all the firm's contracts where the weights equal the share of direct labor used by each contract.

$$A=\sum_{i=1}^{n}\left(\frac{L_i}{\sum_{k=1}^{n}L_k}\right)\phi_i'(C_i). \tag{8}$$

Just as for R^M and C_i, A will be considered a function of the input choices, L, M, Z, and J. However, for expositional convenience, this functional dependence will not be indicated explicitly in the notation.

Proposition 1 will now present the derivative of profit with respect to the variables L_i, M_i, and J. This is the basic technical result that will be used in subsequent sections. Since the proofs involve straightforward differentiation of equation (7), they will not be presented.

Proposition 1:

$$\frac{\partial\Gamma}{\partial M_i}=\phi_i'(C_i)-1; \tag{9}$$

$$\frac{\partial\Gamma}{\partial Z_i}=A-1;\text{ and} \tag{10}$$

$$\frac{\partial\Gamma}{\partial L_i}=R^M[\phi_i'(C_i)-A]+[\phi_i'(C_i)-1]. \tag{11}$$

Intuitive explanations exist for these formulas. The only effect of increasing direct material by one dollar is that the cost of contract i goes up by one dollar and revenue therefore rises by $\phi_i'(C_i)$. The effect on profit is the change in revenue minus the change in cost which is given by equation (9). Now consider equation (10). Suppose that overhead increases by one dollar. (Whether it is Z_i or J is irrelevant since both are allocated in the same fashion.) The change in profit then equals the change in revenue minus one dollar (since one dollar is the change in cost). The increased dollar of overhead is allocated to all contracts in proportion to direct labor cost. Therefore contract i experiences a change in cost of:

$$\frac{L_i}{\sum_{k=1}^{n}L_k}.$$

which causes revenue on contract i to go up by:

$$\left(\frac{L_i}{\sum_{k=1}^{n}L_k}\right)\phi_i'(C_i).$$

The total revenue change is the sum over i of the last expression. This, by definition, is A, the weighted average cost sensitivity.

Expression (11) is more complicated, but the necessary insights have essentially been developed. When direct labor on contract i increases by one dollar, there are two effects. The first is that the cost of contract i goes up by one dollar because all of the dollar increase is directly assigned to contract i. Just as for equation (9), this causes a profit change of $\phi_i'(C_i)-1$, which is the second term of equation (11). The second effect is that the extra dollar of direct labor attracts R^M dollars of overhead to contract i. Suppose that one dollar of overhead is shifted to contract i. This means that one dollar of overhead is taken away from all contracts. By the analysis of equation (10), this causes revenue to decline by A dollars. Since the dollar of overhead is now assigned to contract i, revenues increase by $\phi_i'(C_i)$. Therefore the net change in revenue when one dollar of overhead is shifted to contract i is $\phi_i'(C_i)-A$. Since the dollar of direct labor attracts R^M dollars of overhead, profit changes by R^M times this value. This is the first term of equation (11).

Pure Waste

The derivatives in Proposition 1 give the marginal value to the firm of incurring pure waste. Since equations (9) and (10) are non-positive, the firm will never have an incentive to incur pure waste in its direct material or overhead expenditures. This is because revenue is assumed to increase by at most one dollar when cost goes up by one dollar. Thus, the best result that could possibly occur is that the firm's profit would be unchanged. In general, revenue will go up by less than one dollar, and profit will actually decline.

The more interesting possibility involves direct labor. Just as for direct material, the dollar of direct labor will be only partially reimbursed through revenue, and the change in profit is given by the second term of equation (11), which is negative. However, there is an extra effect as a result of overhead shifting, which is given by the first term of equation (11). In particular, if contract i is more cost sensitive than the weighted average of the firm's contracts, then the firm can increase its revenue by shifting overhead to contract i, where it will be more fully reimbursed. If this effect is large enough, the firm will find it profitable to incur pure waste of direct labor for contract i.

The first term of equation (11) grows larger if the overhead rate, R^M, is larger because direct labor then shifts more overhead. It also grows larger if the differential cost sensitivity, $\phi_i'(C_i)-A$, is larger because contract i will then reimburse a relatively larger fraction of the overhead than if the overhead was allocated to all contracts. The second term of equation (11) is larger if the cost sensitivity, $\phi_i'(C_i)$, is larger because then a greater fraction of direct labor expenditure is reimbursed.

Input Substitution: General

The general input substitution problem will now be described. Assume that the firm can substitute between L_i, M_i, and Z_i. View L_i as the firm's choice variable. Then, assume that the amounts of the other two inputs necessary to produce the desired outputs are given by the two differentiable functions:

$$Z_i=g_i(L_i), \tag{12}$$

and

$$M_i=h_i(L_i). \tag{13}$$

Equations (12) and (13) describe the isoquant on which the firm must operate. Let $\pi(L)$ denote the firm's profit given its choice of labor inputs and given the resulting choice of Z and M required by equations (12) and (13). (View J as fixed at some level for this entire analysis.) Formally, the function $\pi(L)$ is given by equation (7) where Z_i and M_i are determined by equations (12) and (13).

Proposition 2 presents the marginal effect on profit of a change in direct labor (with adjustment of other inputs). The proof simply involves straightforward differentiation, and will not be presented.

Proposition 2:

$$\frac{\partial\pi}{\partial L_i}=[R^M-g_i'(L_i)][\phi_i'(C_i)-A]+[1+h_i'(L_i)+g_i'(L_i)][\phi_i'(C_i)-1]. \tag{14}$$

Further analysis of equation (14) will be conducted in the context of more specific types of input substitution problems in the next two parts. However, before doing this, one general methodological point applying to all of these analyses will be made.

In general two factors affect the firm's profit when the firm substitutes between labor and other inputs. The first is cost efficiency, e.g., if spending one dollar on labor will save ten dollars of some other input, the firm will be inclined to do this. The second factor is the effect of the input substitution on cost allocation, which in turn affects profit. The goal of this article is to analyze the nature of the incentives operating on the firm due to the second factor. Formally, to isolate this second factor, I assume that the firm is currently making a cost-minimizing input choice and then measure the marginal effect of increased labor usage (with a corresponding decrease in other input usage) on profit. That is, I will measure the marginal effect on profit of using one more dollar of direct labor when this causes one dollar less of other inputs to be used. Thus, there is no cost-efficiency effect, and the entire change in profit must be attributed to cost allocation.

Labor-Material Substitution

It will be assumed that:

$$g_i'(L_i)=0 \tag{15}$$

for every L_i. Thus, only substitution between labor and material is considered. As explained above, it will also be assumed that one dollar of increased labor generates one dollar of decreased material; that is,

$$h_i'(L_i)=-1 \tag{16}$$

at the value of L_i for which the derivative is being evaluated.

Substitution of equations (15) and (16) into equation (14) yields:

$$\frac{\partial\pi}{\partial L_i}=R^M[\phi_i'(C_i)-A]. \tag{17}$$

Recall that equation (11) gives the marginal effect on profit of a dollar of pure labor waste. A comparison of equations (11) and (17) reveals that equation (17) equals the first term of equation (11). The reason for this is straightforward. Just as for the pure waste case, spending an additional dollar on direct labor causes R^M dollars of overhead to shift to contract i. However, this is not the only effect because the increased dollar of direct labor expenditure is coupled with a decreased dollar of direct material expenditure. Thus, there is no change in direct cost.

Therefore, the firm will in general have the incentive to distort direct labor usage on all of its contracts, except those of precisely average cost sensitivity. It will want to use too much labor on contracts which are above average in cost sensitivity and too little direct labor on contracts which are below average in cost sensitivity. Its incentive to do this will be greater if the overhead rate is greater and if the variation in cost sensitivity among contracts is greater.

Finally, note that equation (17) is always greater than or equal to equation (11). This means that the firm will not have the incentive to engage in pure waste in situations when input substitution is possible. However, the pure waste model is still interesting for two reasons. First, pure waste may still be an important short run phenomenon. Second, the pure waste model very clearly illustrates the basic incentive structure created by overhead allocation based on direct input usage and it is thus of analytic value.

Labor-Overhead Substitution

It will be assumed that:

$$h_i'(L_i)=0 \tag{18}$$

for every L_i. Thus, only substitution between overhead and labor will be considered. It will also be assumed that one dollar of increased labor generates one dollar of decreased overhead; that is,

$$g_i'(L_i)=-1 \tag{19}$$

at the value of L_i for which the derivative is being evaluated.

Substitution of equations (18) and (19) into equation (15) yields:

$$\frac{\partial\pi}{\partial L_i}=(1+R^M)[\phi_i'(C_i)-A]. \tag{20}$$

A comparison of equations (17) and (20) reveals that the term R^M in equation (17) has been replaced by the term $1+R^M$ in equation (20). The reason for this is that when the firm spends one more dollar on L_i and one less dollar on Z_i, it is directly transferring one dollar of overhead to contract i. This occurs in addition to the fact that the dollar of direct labor attracts R^M dollars of overhead.

Since the labor-material and labor-overhead cases have similar formulas, all of the comments made for the labor-material case apply here as well and they will not be repeated. The only difference is that the incentive to distort the labor-overhead choice will be greater than that to distort the labor-material choice because of the extra direct shift that occurs. It will be shown in section IV that a typical value for R^M is approximately 1. Thus, the incentive to distort the labor-overhead choice might typically be approximately twice as large as that to distort the labor-material choice.

III. Formal Analysis: Equilibrium[2]

To avoid discussion of trivial cases where the firm is indifferent between everything, it will be assumed that at least one product's revenues are not totally cost sensitive. That is, for some product i:

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[2] The analysis of this section does not contribute a great deal of extra economic insight over that contributed by section II. Readers less interested in technical aspects of the analysis may choose to move

$$\phi_i'(C_i)<1 \tag{21}$$

for all $C_i \geq 0$.[3]

In section II, input substitution between labor and material and between labor and overhead were considered as two separate problems. This was analytically useful because the separate considerations involved in each type of substitution could be clearly understood. However, in general the firm will consider substitutions between all three inputs simultaneously. In this section, I will demonstrate that the expected distortions in direct labor occur in a more general model which potentially allows substitutions between all three variables.

Assume that the joint inputs remain fixed at some level J^*. For each product the firm can choose any vector of product-specific inputs satisfying

$$L_i=f^i(M_i,Z_i) \tag{22}$$

for some function f^i (i.e., f^i is the isoquant that the firm operates on).

Two definitions of optimality will be useful. For any input choices the total product-specific cost is given by $L_i+M_i+Z_i$. An input vector $(\hat{L}_i,\hat{M}_i,\hat{Z}_i)$ is first best if it minimizes this cost subject to equation (22). An ordered pair of inputs will be called second best given the third input if it minimizes cost given the third input. Formally, the ordered pair $(\hat{L}_i,\hat{M}_i)$ is second best given $\hat{Z}_i$ if $(\hat{L}_i,\hat{M}_i,\hat{Z}_i)$ minimizes product-specific cost subject to equation (22) and subject to $Z_i=\hat{Z}_i$. All other notions of second best for other ordered pairs of inputs are defined analogously.

The properties that f^i is assumed to satisfy are as follows:

1. The function f^i is defined over the non-negative reals and maps into the non-negative reals. It is twice continuously differentiable.
2. There is a unique first-best input vector. Denote it by (L_i^F,M_i^F,Z_i^F).
3. There is a unique second best (L_i,M_i) given Z_i. Let $L_i^s(Z_i)$ and $M_i^s(Z_i)$ denote the two functions determining these values.
4. There is a unique second best (L_i,Z_i) given M_i. Let $L_i^s(M_i)$ and $Z_i^s(M_i)$ denote the two functions determining theses values
5. $f_M^i<0$; $f_Z^i<0$.
6. $f_{MM}^i>0$; $f_{ZZ}^i>0$; $f_{MM}^i f_{ZZ}^i-(f_{MZ}^i)^2>0$.
7. $f_{MZ}^i<0$; $f_M f_{MM}-f_Z f_{MZ}>0$; $f_Z f_{ZZ}-f_M f_{MZ}>0$.

Assumptions 1 through 4 simply require f^i to be a smooth function with solutions to the various cost-minimization problems of interest. Assumption 5 states that Z_i and M_i are substitutes for L_i, and assumption 6 simply requires f^i to be convex. Given the above assumptions, assumption 7 is equivalent to the assumption that all inputs are strong substitutes in the sense that the second-best inputs, given the third input, are both de-

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directly to section IV. Only the input substitution case will be considered. An analysis of the pure waste case can be found in Rogerson (1990).

[3] Technically, this assumption plays the following role in the various proofs. In most cases the first order conditions will be satisfied if $\phi_i'(C_i)=1$ for every i. In such a case the firm is indifferent between all cost allocations and, in general, anything could be true. Assumption (21) rules out this possibility. Then the first order conditions generally imply a great deal of structure for the resulting equilibrium.

creasing in the third input. That is, if the third input goes up, then it is optimal to reduce use of both of the other inputs.

The firm's optimization problem can now be formalized as follows. Let $\Gamma(L,M,Z)$ denote the firm's profit when J is held at its fixed value; that is,

$$\Gamma(L,M,Z)=\Gamma(L,M,Z,J^*). \tag{23}$$

Then the firm's problem can be written as:

$$\text{Maximize} \quad \Gamma(L,M,Z) \tag{24}$$

$$\text{subject to} \quad L_i=f^i(M_i,Z_i) \text{ for every } i. \tag{25}$$

It will be assumed that a unique interior solution exists to equations (24) and (25) characterized by the first-order conditions. Let asterisks denote the values of variables in the solution; that is, (L_i^*,Z_i^*) is the solution for product i, C_i^* is the resulting cost for product i, A^* is the resulting weighted average cost sensitivity, and so on.

Proposition 3 states the major result that in equilibrium, the firm uses too much (too little) direct labor on products which are of above average (below average) cost sensitivity.

Proposition 3:

$$L_i^* \overset{>}{\underset{<}{=}} L_i^F \Leftrightarrow \phi_i'(C_i^*) \overset{>}{\underset{<}{=}} A^*. \tag{26}$$

Proof: See Appendix.

This is precisely the expected result based on the analysis of section II.

Proposition 4 states that the expected distortions also occur with respect to the second best criteria. In fact the method of proof is to first prove Proposition 4. Then Proposition 3 follows immediately because of Assumption 7.

Proposition 4:

$$L_i^* \overset{>}{\underset{<}{=}} L_i^s(Z_i^*) \Leftrightarrow \phi_i'(C_i^*) \overset{>}{\underset{<}{=}} A^*, \text{ and} \tag{27}$$

$$L_i^* \overset{>}{\underset{<}{=}} L_i^s(M_i^*) \Leftrightarrow \phi_i'(C_i^*) \overset{>}{\underset{<}{=}} A^*. \tag{28}$$

Proof: See Appendix.

IV. Empirical Estimates of the Magnitude of the Incentive Effects

In section II, formulas were developed to determine the marginal impact of direct labor usage on profit as a function of various parameters, including the overhead rate and cost sensitivity of the firm's contracts. In this section, I will substitute in plausible values for these parameters and thus estimate plausible values for the marginal impact of direct labor usage on profit.

One remark regarding interpretation should be noted about these estimates. In the equilibrium calculated in section III, the firm will have taken advantage of all such opportunities to increase its profit and the marginal effect of direct labor on profit will generally be zero. (This is the first-order condition.) Thus, in the context of the model presented in section III, one should interpret the calculations of this section as providing plausible estimates of the incentives to engage in pure waste prior to actually doing so. Alternatively, note that the model of section III did not allow auditing to play any role at all in restraining firms' choices. In reality, firms may often perceive that there are positive marginal returns to engaging in direct labor distortions but that auditing prevents them from doing so. Thus, one could also interpret the calculations of this section as providing estimates of the actual equilibrium incentives in a more complicated model where auditing partially restrains behavior.

Description of the Generalized Model

The major exception to the general rule that most defense firms allocate most of their overhead on the basis of direct labor concerns an overhead element usually labelled general and administrative (G&A). This basically consists of the cost of central management functions. It is typically allocated over a base that includes direct labor as one of its elements but that also includes other elements. In order to make best use of the actual data it will be useful to complicate the formal model of section II to capture this.

In the generalized cost allocation model, direct labor and material are still denoted by L_i and M_i. The overhead described in section I still exists, can be broken into product-specific and joint components, and is allocated according to direct labor. However, it will now be called manufacturing and engineering (M&E) overhead. The overhead rate, R^M, will now be called the M&E overhead rate. There is now an additional overhead pool for the general and administrative (G&A) costs. Let G denote its dollar value. It will be assumed that all of the costs in G are joint.

The G&A pool is allocated according to total cost input. Define the total cost input for contract i, denoted by T_i, to be direct labor and material plus the allocated share of the M&E pool.

$$T_i=M_i+L_i(1+R^M). \tag{29}$$

Let G_i denote the amount of G&A overhead allocated to contract i. It is given by:

$$G_i=\frac{T_i}{\sum_{k=1}^{n} T_k}G. \tag{30}$$

Let R^G denote the G&A overhead rate given by:

$$R^G=G\Big/\sum_{k=1}^{n} T_k. \tag{31}$$

Then equation (30) can be rewritten as:

$$G_i=T_iR^G. \tag{32}$$

The total cost of contract i, denoted by C_i, is given by:

$$C_i=L_i+M_i+V_i+G_i. \tag{33}$$

Before proceeding to the calculation of formulas for the marginal effect on profit, one further simplification will be introduced. In the analysis of the single pool cost allo-

Table 1
The Marginal Effect on Profit of Direct Labor Expenditures

Type of Direct Labor Increase	*No G&A Pool (One Pool)*	*G&A Pool (Two Pool)*
Pure waste	$R^M[\phi_i'(C_i)-A]+[\phi_i'(C_i)-1]$	$D[\phi_i'(C_i)-A]+[\phi_i'(C_i)-1]$
Labor-material substitution	$R^M[\phi_i'(C_i)-A]$	$(D-R^G)[\phi_i'(C_i)-A]$
Labor-overhead substitution	$(1+R^M)[\phi_i'(C_i)-A]$	$(1+D)[\phi_i'(C_i)-A]$

cation system in section II, the weighted average cost sensitivity, A, as defined by equation (8), played a role because the weights corresponded to overhead shares. In the two-pool analysis of this section, the parameter A will continue to play a role because M&E overhead is still allocated according to these shares. However, G&A is allocated according to different shares. In particular, contract i will receive the share:

$$\frac{T_i}{\sum_{k=1}^{n} T_k}$$

of G&A overhead. Therefore it should not be surprising that the weighted average cost sensitivity calculated according to these weights will also play a role. Call this value A^T.

$$A^T=\sum_{i=1}^{n}\left(\frac{T_i}{\sum_{k=1}^{n} T_k}\right)\phi_i'(C_i). \tag{34}$$

In general, there is no reason to believe that A and A^T will be the same. Generally speaking, this would only be true if the ratio L_i/M_i stayed constant across contracts. However, for purposes of empirical implementation, no data is available on how this ratio varies between contracts and how this variation is correlated with cost sensitivity. Therefore it will be assumed that A^T and A are equal. Let A denote this common value.

The Generalized Model: Analysis

In order not to repeat all of the steps of section II only the results will be reported here.[4] Formulas for the one-pool case derived in section II, and the corresponding formulas for the two-pool case are shown in table 1. The term D in the formulas for the two-pool case is defined by:

$$D=R^M+R^G(1+R^M). \tag{35}$$

Intuitive explanations exist for the changes which occur in the formulas. In the pure waste case, R^M is replaced by D. In the one-pool case, a dollar of direct labor attracts R^M dollars of overhead. However, in the two-pool case a dollar of direct labor attracts D dollars of overhead. It attracts R^M dollars from the M&E pool. However, this creates $(1+R^M)$ dollars of total cost input which in turn attracts $R^G(1+R^M)$ dollars from the G&A pool. The sum of these two terms is D. In the case of labor-material substitution, the term R^M is replaced by the term $D-R^G$. In the single-pool case, substitution of a dollar of direct labor for a dollar of direct material attracts R^M dollars of overhead to contract i. However, in the two-pool case, the increased dollar of direct labor attracts D dollars of overhead but the reduced dollar of direct material takes away R^G dollars of overhead. The net amount of overhead attracted is $D-R^G$ dollars.

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[4] See Rogerson (1990), section 5 for a complete derivation.

In the case of labor-overhead substitution, the term $1+R^M$ is replaced by the term $1+D$ because one dollar of direct labor now attracts D dollars of overhead.

In summary, all of the formulas for the two-pool case are simply the natural analogs of those for the single-pool case where adjustments are made for two differences: (1) direct labor attracts D dollars of overhead instead of R^M dollars of overhead and (2) direct material now attracts R^G dollars of overhead instead of zero dollars of overhead.

Empirical Estimation

To estimate plausible values for the size of the marginal impact of direct labor on profit, plausible values for the overhead rates, R^M, R^G and D, and the cost sensitivity parameters, $\phi_i'(C_i)$ and A, must be determined.

The values of R^M and R^G will be set equal to the average 1987 values for four major aerospace contractors: General Dynamics, Grumman, McDonnell Douglas, and Northrop. The data for these calculations is from a study of the cost-accounting systems of these firms.[5] The breakdown of costs into various cost pools is as follows:[6]

Cost Type		*Percent of Total*
Direct Labor		20.1
Direct Material		51.9
Overhead		28.0
G&A	8.1	
M&E	19.9	
Total		100.0

The calculations for the overhead rates R^M, R^G, and D are 0.99, 0.09, and 1.17, respectively.

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[5] McCullough and Balut (1990). I am particularly indebted to Jim McCullough for answering many questions regarding the interpretation of their data. In Rogerson (1990), it is shown that similar values for overhead rates can also be derived using a different data set compiled by Myers et al. (1985).

[6] A number of adjustments had to be made to the data from McCullough and Balut (1990). A complete description of these adjustments is contained in appendix E of Rogerson (1990). The only extremely significant adjustment is the inclusion of fringe benefits for direct labor as part of direct labor. Firms normally classify fringes as part of overhead, but no incentive problem is created by placing fringes in the overhead pool. This is because the firm cannot spend an extra dollar on direct labor without also spending proportionately more on fringes as well. Therefore the correct procedure for estimating the magnitude of incentive effects is to remove fringe benefits from the overhead pool and reclassify them as direct. Note that this adjustment lowers the calculated overhead rates and thus reduces the magnitude of the estimated incentives to distort labor.

Table 2

The Marginal Impact of Direct Labor on Profit When $\phi_i'(C_i)=1$

Case	$A=0.828$	$A=0.621$
Pure waste	0.20	0.44
Labor-Material substitution	0.19	0.41
Labor-Overhead substitution	0.39	0.82

No good data exist for determination of plausible values for the cost sensitivity parameters, $\phi_i'(C_i)$ and A, so this is the weakest step of the procedure. The parameter $\phi_i'(C_i)$ can be assumed to equal 1. Most procurement analysts tend to view well-funded sole source contracts as exhibiting cost sensitivities at or close to 1. Therefore this section can be interpreted as estimating the incentive to distort labor use on a well-funded sole source contract. The more problematic issue regards determining a value for the average cost sensitivity of all of the firm's contracts, A. Two estimates will be created, and these can be viewed as providing a range of plausible values.

The first estimate is constructed by assuming that all of the firm's government contracts are completely cost sensitive and that all of its commercial contracts are completely cost insensitive. Then the industry average for the proportion of government business can be used to construct the value of A. Let g denote the fraction of direct labor used by the firm's government contracts. Then A equals g. The DOD (1985) found that, on average, major defense contractors' business was 82.8 percent government and 17.2 percent commercial, yielding an estimate for A of 0.828.

There is a sense in which this estimate is biased upwards. Although it is reasonable to assume that all of a firm's commerical business is priced independently of accounting costs, it is probably not as reasonable to assume that all of its defense business is perfectly cost sensitive. To the extent that some of a typical firm's defense business is less than perfectly cost sensitive, this will tend to lower the value of A. To account for this, the second estimate is constructed using the (fairly arbitrary) assumption that one-half of the firm's government business is perfectly cost sensitive and the other half has a cost sensitivity equal to 0.5, yielding:

$$A=0.5(g+0.5g). \qquad (36)$$

Substitution of $g=0.828$ into equation (36) yields a value for A of 0.621.

The results of substituting the above parameter values into the formulas from table 1 for the two-pool case are given in table 2.

The magnitude of the incentive effect is extremely large. For the pure waste case, for example, wasting a dollar and calling it direct labor generates between \$1.20 and \$1.44 of revenue. The incentive effect for material-labor substitution is slightly smaller because material attracts G&A. Thus, the net amount of overhead shifted is smaller. The incentive effect for labor-overhead substitution is much larger, about twice the size of the pure waste case, because of the extra direct shifting that occurs.

V. Discussion and Policy Implications

In this section I will briefly discuss a number of applications, predictions, and extensions of the model and conclude with possible policy approaches. See Rogerson (1990) for a more detailed discussion.

Automation

The evidence suggests that defense production is underautomated (DOD 1985, chap. VI; Gansler 1980, 57–58). The traditional explanation is that DOD pricing formulas may not fully compensate firms for the true economic cost of facilities capital investment. This article shows that there may still be a very significant incentive for firms to under-invest in automation of defense production even if the economic cost of capital investment is being correctly calculated. According to the estimates of section IV, even if the regulations succeed in correctly compensating the firm for its true facilities capital cost, the firm will still perceive that it can earn between 39¢ and 82¢ in pure economic profit by substituting $1.00 of direct labor for $1.00 of (annualized) facilities capital costs on a well-funded sole source procurement.

Spare Parts

A series of so-called "spare parts pricing scandals" plagued the DOD in the mid-1980s (Rasor 1985, chap. 5; Fitzgerald 1989, chap. 12). Both critics and supporters of the DOD basically agreed that: (1) the prices charged and paid generally were equal to fully allocated cost and (2) a very large part of the fully allocated cost was overhead allocated in the same fashion as for all of the firm's other contracts. Supporters tended to view the equality of prices and costs as evidence that there was no problem. They argued that overhead costs are legitimate and spare parts merely picked up their normal share. It is fair to say that critics could offer no explicit intellectually sound counter argument to this view.

This article suggests an intellectually sound explanation for why the overhead allocation process might tend to create both inefficiencies and overly high prices in the procurement of spare parts. Spare parts contracts are likely in many cases to be highly non-competitive because they occur near the end of a program when the threat of bringing in a new source is very low. Furthermore, the government has a fairly large need for the parts in order to keep the existing fleet operative and the dollar value of the spare parts is relatively low. Therefore, defense firms will have the incentive to purposely overuse direct labor on spare parts contracts in order to shift more overhead to these contracts. To the extent that this occurs, it will both generate inefficiencies and raise prices.

Many of the published cost-breakdowns for spare parts are in fact mildly suggestive of this phenomenon. A typical example is the cost breakdown reported by Rasor (1985, 165) for a hammer. The firm purchased the hammer for $9.00; it incurred direct labor costs of $130.00 in "handling and inspecting" the hammer, and $240.00 of overhead was allocated (shifted) to the hammer.

Dual Sourcing[7]

In weapons programs with moderately large production runs such as missiles it has become relatively common for the DOD to simultaneously purchase output from two separate suppliers. Bids are solicited from both firms for a range of possible outputs and the lower bidder is given a larger share of the procurement. The evidence suggests that dual sourcing causes fully allocated costs to drop. This article supplies a theoretical explanation for this behavior. Dual sourcing a defense program is likely to render such a program below average in cost sensitivity. Consequently, the firm will purposely under use direct labor and eliminate all possible direct labor waste, resulting in overhead being shifted to other contracts and thus reducing fully allocated cost.

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[7] I particularly benefitted from discussions with Jim Dertuzos in preparing this section.

Traditional procurement analysts have typically accepted a \$1.00 reduction in fully allocated cost due to dual sourcing as representing a \$1.00 savings to the government. This article identifies the fallacy in this interpretation. The bulk of cost reductions may be caused by the reallocation of overhead. If costs are reallocated to other defense contracts there would be no total cost savings to the government.

Incentives Within the DOD Bureaucracy

This article has focused on the incentives of profit maximizing firms and ignored incentives within the DOD bureaucracy. However, overhead allocation has a potentially enormous impact on decision makers' incentives within the DOD. In particular, individual decision makers within the DOD will generally have the incentive to try to minimize the fully allocated cost of the program or programs for which they are responsible. Thus, a program manager within the DOD might quite rationally prefer to use dual sourcing if it lowers his or her own program's fully allocated cost simply by shifting overhead to other defense programs. At a slightly higher level of the bureaucracy, an individual military service might well prefer to use dual sourcing so long as the overhead is shifted to programs purchased by other services. Thus, dual sourcing may be the result of a noncooperative overhead shifting game being played by decision makers within the DOD.

This incentive to shift overhead may distort a broad range of decisions within the DOD besides the dual-sourcing decision. For example, a program manager will have a disproportionately large incentive to monitor direct labor costs as opposed to costs accumulated in overhead pools. Similarly, individual program managers or services may avoid placing contracts with firms exhibiting a large amount of excess capacity desired by the manager of some other program or service. Essentially the same issue has recently received attention from accountants studying distorted decision making within the bureaucracy of (purely) commercial private firms (Johnson and Kaplan 1988).

Subcontracting

The subcontracting decision can be modeled as an input substitution decision. When the firm brings production in-house it records less direct material cost but more direct labor and overhead cost. Rogerson (1990) shows that the qualitative nature of the distortion in the subcontracting decision will be determined by the material-labor substitution so long as one plausible sufficient condition called the decreasing overhead rate property (DORP) is satisfied.[8] Thus, the prediction of this article is that a defense firm will keep too much production in-house for its defense products and subcontract too much for its commercial products.

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[8] The DORP is simply that the firm's overhead rate, R^M, decreases if it brings more business in-house. It is a well-accepted stylized fact in defense procurement that this condition is generally true. The reason typically given for this is the existence of "fixed costs" in the overhead pool which should be thought of as representing economies of scale or scope.

This prediction seems broadly consistent with the known evidence. A considerable amount of the DOD's cost-monitoring activity is devoted for reviewing the adequacy of firms' make-or-buy decisions. Both Peck and Scherer (1962, 386–91) and Gansler (1980, 132–37) suggest that defense firms tend to want to produce too much of their defense products in-house.

Policy Implications

The defining characteristic of traditional cost-accounting practices used by both defense and non-defense firms is that very little effort is devoted towards allocating costs directly.[9] Thus, there are many costs currently included in overhead that could in principle be allocated directly to products. Perhaps the major policy implication of this article is that greater effort to directly allocate more costs would be worthwhile because the resulting decrease in overhead rates would reduce the incentive problems identified in this article.

A second policy implication concerns the treatment of joint costs. The DOD's current practice is to allocate these costs to products. To the extent that these costs are allocated to defense products and to the extent that price is sensitive to accounting costs charged to these products, the DOD will then pay for a share of these joint costs. An alternate method of paying for these joint costs would be for the DOD to directly negotiate payments on a firm-wide basis and for no allocation to individual products to occur. This would lower overhead rates and thus reduce the incentive problems identified by this article. This approach would be particularly easy to implement for joint expenses such as G&A and IR&D/B&P,[10] since they are already separately identified by firms' cost-accounting systems.

Appendix

Proof of Propositions 3 and 4

Two lemmas will be stated to more clearly define what needs to be proven. Since the proofs of the lemmas are straightforward, they will not be given.

Lemma 1 states that if the labor choice is too large (too small) relative to both second best criteria, then the labor choice is also too large (too small) relative to the first best criterion.

Lemma 1

Consider a vector of inputs (L_i, M_i, Z_i) which satisfies:

$$L_i = f^i(M_i, Z_i). \tag{A1}$$

Suppose that:

$$L_i > (=;<) L_i^s(M_i), \tag{A2}$$

and

$$L_i > (=;<) L_i^s(Z_i) \tag{A3}$$

Then,

$$L_i > (=;<) L_i^F. \tag{A4}$$

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[9] See Johnson and Kaplan (1987), Berliner and Brimson (1988), and Cloos and McCullough (1989).

[10] IR&D/B&P refers to independent research and development and bid and proposal expenses incurred by defense contractors as part of their defense business. See Rogerson (1990).

The significance of this lemma is that it means that Proposition 3 follows directly from Proposition 4. Therefore, it is sufficient to prove Proposition 4. Note that the only role of Assumption 7 in the proof is to guarantee that Lemma 1 is true.

Lemma 2 now establishes conditions which determine where L^i is too large or small relative to the second best criterion.

Lemma 2

Consider a vector of inputs satisfying equation (A1). Then:

$$L_i \gtreqless L_i^*(M_i) \Leftrightarrow f_M^i(M_i,Z_i) \lesseqgtr -1. \qquad \text{(A5)}$$

$$L_i \gtreqless L_i^*(Z_i) \Leftrightarrow f_Z^i(M_i,Z_i) \lesseqgtr -1. \qquad \text{(A6)}$$

Therefore, it is sufficient to prove the following two statements:

$$\phi_i'(C_i^*) \gtreqless A^* \Leftrightarrow f_M^i(M_i^*,Z_i^*) \lesseqgtr -1. \qquad \text{(A7)}$$

$$\phi_i'(C_i^*) \gtreqless A^* \Leftrightarrow f_Z^i(M_i^*,Z_i^*) \lesseqgtr -1. \qquad \text{(A8)}$$

Substitute equation (22) into $\Gamma(L,M,Z)$ so that profit is a function of M and Z. Denote this function as $\gamma(M,Z)$. The first-order conditions for the firm's optimization problem are then:

$$\frac{\partial\gamma}{\partial M_i}(M^*,Z^*)=0 \qquad \text{(A9)}$$

and

$$\frac{\partial\gamma}{\partial Z_i}(M^*,Z^*)=0. \qquad \text{(A10)}$$

It will now be shown that equation (A9) implies equation (A7) and equation (A10) implies equation (A8).

First consider equations (A7) and (A9). Rewrite equation (A9) as:

$$\frac{f_M^i\left(\sum_{k=1}^{n} Z_k^* + J\right)}{\sum_{k=1}^{n} f^k}[\phi_i'(C_i^*)-A^*]+(f_M^i+1)[\phi_i'(C_i^*)-1]=0. \qquad \text{(A11)}$$

In the above equation, the function f^i and its derivative are evaluated at (M_i^*,Z_i^*). That is, f^i denotes $f^i(M_i^*,Z_i^*)$, f_M^i denotes $f_M^i(M_i^*,Z_i^*)$, and so on. This convention will be used throughout the appendix. By assumption, f_M^i is negative and $[\phi_i'(C_i^*)-1]$ is nonpositive. Therefore, there are two cases to consider. First suppose that:

$$\phi_j'(C_j^*)=1, \qquad \text{(A12)}$$

for some j. Then, by equation (A11):

$$A^*=1. \qquad \text{(A13)}$$

Since the average value of the derivatives is 1 and no derivative can be greater than 1, this implies that all derivatives equal 1. That is:

$$\phi_i'(C_i^*)=1, \qquad \text{(A14)}$$

for every i. This contradicts equation (21). Therefore, the first case cannot occur.

In the second case,

$$\phi_i'(C_i^*)<1, \qquad \text{(A15)}$$

for every i. In this case equation (A11) immediately implies equation (A7).

Now consider equations (A8) and (A10). Rewrite equation (A10) as:

$$\left[\frac{f'_z\left(\sum_{k=1}^{n} Z_k^* + J\right)}{\sum_{k=1}^{n} f^k} - 1\right][\phi'_j(C_j^*) - A^*] + (f'_z + 1)[\phi'_i(C_i^*) - 1] = 0. \qquad \text{(A16)}$$

Since f'_z is negative, the entire term,

$$\frac{f'_z\left(\sum_{k=1}^{n} Z_k^* + J\right)}{\sum_{k=1}^{n} f^k} - 1, \qquad \text{(A17)}$$

is negative. The proof that equation (A17) implies equation (A8) now parallels the proof that equation (A11) implies equation (A7).

QED

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Cost Manipulation Incentives Under Cost Reimbursement: Pension Costs for Defense Contracts

Jacob K. Thomas
Columbia University
Samuel Tung
University of Otago

SYNOPSIS AND INTRODUCTION: This article examines the incentives for defense contractors that operate under cost reimbursement to manipulate pension costs. We investigate pension costs because of their high discretionary component and their importance to managers seeking to manipulate costs. For example, two of the 20 standards issued by the Cost Accounting Standards Board (CASB) focus exclusively on the determination of allowable pension costs.[1] Also, the availability of detailed data on pension funding and actuarial variables across plans sponsored by the same firm and across plans of different firms allows for extensive tests of the hypothesized effects of cost reimbursement. Defense contractors are selected because they are closely associated with cost reimbursement (see, e.g., Chwastiak 1990; Pownall 1986), and the terms "defense" and "non-

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[1] The CASB was established in response to allegations of cost overstatements by defense contractors. Although it ceased operations in 1980, the standards continued to have the full force of law and now apply to all federal procurements. After a long hiatus and much political bickering, the CASB has been resuscitated and a new five-member board has been appointed to pursue the backlog of problems and issues that have developed in the interim. The original standards, rules, and regulations of the CASB are contained in Title 4, Chapter III, Code of Federal Regulations. Each standard constitutes a part of Title 4 and is identified by a three-digit number, starting with 401. Various summaries (e.g., Price Waterhouse 1984) describe the essential features of these standards.

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defense" are used here to denote the presence and absence, respectively, of reimbursed costs.[2]

The analysis suggests that overfunding is valuable to defense contractors only if they also have or plan to have non-defense business. Two generic funding strategies are described: across-time and across-contract. In both cases, plans are overfunded when employees work on defense contracts, then these excess pension assets are withdrawn when the employees work on non-defense business. The across-contract strategy is implemented by transferring employees and associated pension assets and liabilities between defense and non-defense plans. The across-time strategy is implemented by having individual plans alternate between extended periods wherein they first cover defense contracts, then cover non-defense business. The firm can achieve this effect either by selectively "cycling" defense contracts across plans or by changing its proportion of defense contracts over time.

Evidence of inter- and intra-firm variation in funding levels and actuarial variables is presented for a sample of 80 major defense contractors. Across firms, funding levels increase with the proportion of defense revenues, reach a peak when defense revenues equal non-defense revenues, and then *decrease* as the proportion of defense revenues increases (an inverted-*U*-shaped relation). This last downward sloping portion of the relation is consistent with the across-contract strategy as it indicates reduced ability to make transfers as the pool of non-defense employees declines. Although evidence of such transfers between defense and non-defense plans could not be obtained, indirect support for this view is provided at the intra-firm level. Relative to a control sample, defense contractors sponsor more plans (which is consistent with their having separate plans for defense and non-defense activities) and exhibit a wider range of funding levels and actuarial variables across plans sponsored by each firm (which is consistent with differential funding of the two groups of plans).

Two important features regarding the scope of this study are worth noting. First, cost reimbursement could also create incentives to inflate pension costs by increasing the level of promised pension benefits (more generous benefits), or by using various allocation strategies, whereby more *common* pension costs are allocated to defense contracts. Although we are unable to investigate these incentives due to data limitations, our inter- and intra-firm results are not confounded by these effects. Second, our results do not prove systematic "overcharging," as competition among suppliers and the ability of customers to identify and adjust for unusually high pension costs are not examined.

Key Words: *Cost reimbursement, Pension funding, Defense contractors, Actuarial assumptions.*

Data Availability: *Data used in this study will be made available upon request.*

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[2] As discussed in section I, costs are not reimbursed for all defense contracts. Even where costs are reimbursed, the extent of reimbursement varies across contracts.

THE remainder of this article is organized as follows. In section I, we describe the benefits of overfunding under a reimbursed-cost type contract and generate testable predictions for defense contractors. Overfunding and underfunding are defined relative to a "base" amount of funding that would have occurred in the absence of cost-reimbursed contracts. In section II, we report results from an empirical examination of the relation between funding levels and proportion of revenue from defense contracts for a sample of 80 major Department of Defense (DOD) contractors. Intrafirm variation in funding levels and actuarial variables is also examined. A brief summary of these results and their implications is provided in section III.

I. Incentives to Overfund Under Cost Reimbursement

We first provide some background relating to two underlying pension issues: the general process by which defined benefit pension plans can be overfunded, and some specific details of the applicable standards of the CASB as they relate to this analysis. Next, the extent to which costs are reimbursed for defense contractors is examined. Then we describe the conditions under which overfunding is valuable when costs are reimbursed, and conclude with testable predictions of the hypothesized incentives.

Overfunding of Defined Benefit Plans and Relevant Pension Costs for Defense Contracts

Firms sponsoring defined benefit plans can affect the timing of their contributions to the fund by selecting different actuarial methods and assumptions. While the benefits paid out after retirement are independent of these actuarial variables, current regulations allow wide variation in the pattern of periodic contributions made before the employees retire. Two important sets of constraints limit this flexibility. Tax regulations designed to prevent undue abuse of the tax benefits of such pension plans (Tepper 1981) limit the *maximum* contributions allowed as deductions (i.e., they limit the prefunding allowed). Provisions of the Employee Retirement Income Security Act of 1974 (ERISA), which are designed to protect employee benefits, and Pension Benefit Guaranty Corporation (PBGC) regulations specify the *minimum* contributions necessary. They also require that an enrolled actuary certify that the actuarial variables selected are reasonable in an overall sense.

Allowable pension costs for defense contracts are described in a general way by the Federal Acquisition Regulation System as defined in Chapter II, Code of Federal Regulations, and in a more specific way by the two CASB standards relating to pension costs: CAS Nos. 412 and 413. The CASB standards define allowable pension costs in ways that are generally consistent with tax rules, but are slightly more stringent than ERISA rules. The CASB guidelines are also very similar to Generally Accepted Accounting Principles under APB Opinion No. 8 (AICPA 1966), with one important exception: only amounts *contributed* to the fund by the date established for filing a federal income tax return are allowed.[3] Unlike tax, accounting, and ERISA rules, the CASB rules also contain specific features designed to prevent the transfer of pension costs from other activities and time periods.

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[3] Although APB Opinion No. 8 allowed firms to report a pension expense that differed from the contribution, the two amounts were typically the same (Francis and Reiter 1987). After SFAS No. 87 (FASB 1985), however, the two amounts are different. Our sample period precedes SFAS No. 87.

Cost Reimbursement for DOD Contracts

The amount of reimbursement generated, say x dollars, for each *additional* dollar of pension contribution (overfunding) varies across contracts according to such factors as type of contract signed and degree of competition among contractors. To illustrate the variation in x, we provide a brief overview of the DOD procurement process (Chwastiak [1990], is an excellent source for additional details and references for the stylized facts described here). The DOD procures goods and services primarily through negotiated purchases; although sealed bid procurement is encouraged, it is used only 5 percent of the time (DOD 1987). The three most common negotiated contract types are: (1) firm fixed price, (2) fixed price incentive, and (3) cost-plus-fixed-fee. The following linear relation between revenues, costs, and profits can be used to compare the three types of contracts:

$$\text{Revenue} = \text{Target Cost} + \text{Target Profit} + \alpha\ (\text{Actual Cost minus Target Cost}), \qquad (1)$$

where α, a factor that varies between zero and 1, captures the risk of cost overruns borne by the contractor. It equals zero for firm fixed price contracts (contractor bears all the risk), equals 1 for cost-plus-fixed-fee contracts (contractor bears no risk), and takes on intermediate values (typically between 0.7 and 0.8) for fixed price incentive contracts.

In the simplest case, x equals α when the overfunding is done *ex post* (i.e., the excess contribution is a cost overrun that was not included in target costs). Even if the overfunding is not done *ex post*, x exceeds zero if the overfunding is (1) included in the negotiated target costs, or (2) used to determine target profits. For example, even for firm fixed price contracts with α equal to zero, x equals the fraction of any overfunding that is negotiated as an allowable target cost in determining the fixed price, and x could exceed 1 if target profits are positively related to target costs. Finally, x could also be influenced by adjustments outside the original contract, initiated either by the contractor or the DOD, to compensate for unforeseen events.

All of the above factors that determine x (the amount of overfunding reimbursed) are in turn related to various attributes of the contractor (such as size and expertise) and the nature of the item procured (such as the stage of development and competition among potential suppliers). Given the variation in contractor attributes and items procured, x is expected to vary across contracts from zero to values that exceed 1.

Potential Advantages of Overfunding Under Cost Reimbursement

Certain other incentives to inflate costs in cost-reimbursed contracts are not considered. For example, if x is greater than 1, the contractor might seek to increase pension costs by providing more generous pension benefits. Similarly, incentives always exist to reclassify or transfer pension costs from other activities where costs are not reimbursed, even for x less than 1. For example, firms could carefully select allocation bases to maximize the defense component of contributions to a *common* company plan that covers employees engaged in both defense and non-defense work. Case studies of defense contractors using such allocation strategies are described in a report to the Congress by the Comptroller General (GAO 1977), and one objective of CAS No. 413 is to limit the latitude available along this dimension. Although such considerations might be important in practice, we are unable to investigate them because of data limitations. However, since such strategies do not create incentives to overfund, they are unrelated to the analysis and results presented here.

A study of the relevant pension and CASB rules provides the following conclusions regarding the incentives to contribute an additional dollar of overfunding, given that it results in a reimbursement of x dollars (see app. A for details). First, no overfunding is expected if all of the contractor's activities (currently and in the future) involve cost reimbursement. The intuition underlying this result is that each dollar of overfunding, along with any accumulated interest, has to be withdrawn eventually since the total benefits to be paid to employees are not influenced by funding policy. Thus, the pension contribution and the associated reimbursement during the "withdrawal" phase is correspondingly lower than base funding, what it would have been without the initial overfunding. Second, overfunding is valuable if costs are not being reimbursed (due to non-defense business) during the withdrawal phase. In essence, plans are overfunded by using more conservative (relative to base funding) actuarial methods and assumptions when costs are reimbursed, and prior overfunding is depleted by using more reasonable methods and assumptions (representing base funding) when costs are not reimbursed.

Two ways to benefit from overfunding, labelled the "across-contract" and "across-time" strategies, are discussed next. Under the across-contract strategy, separate plans are sponsored for defense and non-defense activities, and employees are transferred between these plans along with actuarially computed pension assets and liabilities. Transfers from relatively overfunded defense plans cause the non-defense plans to require lower pension contributions than they would otherwise. Similarly, transfers from the non-defense plans cause the defense plans to have insufficient funding under the more conservative actuarial variables. This shortfall necessitates additional pension contributions which, in turn, generate reimbursements from defense contracts.

The across-time strategy requires that plans operate for a period under defense contracts, then operate for a "holiday" period under non-defense business.[4] Firms can either wait for the switch between defense and non-defense business to occur for natural reasons unrelated to the accross-time strategy, or they can simulate a switch between the two regimes by sponsoring multiple plans and "cycling" their defense contracts over the plans so that each plan alternates between the two regimes.[5] Unlike the latter (plan-wise) variant of the across-time strategy, the former (firm-wise) variant does not require separate plans, and thereby avoids the incongruity associated with the same sponsor using different actuarial assumptions and methods for different plans.[6]

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[4] Each of these periods should be fairly extended since (1) changes from one desired funding level to another take a number of years to accomplish because of the smoothing built into accepted actuarial procedures, and (2) frequent changes in actuarial assumptions and methods needed to accomplish the changes in desired funding levels might attract the attention of the DOD and the certified actuary.

[5] While the defense contractor might be uncertain about the timing of and reasons for the switch to non-defense business, the only requirement is an expectation that such a switch might occur at some future date. The switch would also occur if the regulatory environment changes and costs are no longer reimbursed. While such a regime change did not occur for defense firms during the period studied here, it could be important for certain other industries associated with cost reimbursement; e.g., the deregulation of long-distance phone services and the breakup of the American Telephone and Telegraph Company in January, 1984.

[6] Firms using the plan-wise variant would need to justify to the government, and obtain approval from the certified actuary for, the use of different discount rates to present value future benefits for different plans. Such differences can be partially justified by differences in plan attributes, such as the profile of maturities of the expected benefit payments. More often, the sponsor relies on the freedom to choose from different portfolios of actuarial variables as long as each portfolio is reasonable in aggregate; e.g., it is reasonable to use a set of

Because neither variant of the across-time strategy requires inter-plan transfers it is simpler to implement than the across-contract strategy.

To what extent are pension costs reimbursed for defense contractors and how easy is it to implement the across-time and across-contract strategies? Communications with some of the sample firms, their auditors, and officials of the regulatory agencies suggest that a substantial amount of cost reimbursement in one form or another occurs for the sample of major defense contractors examined here (see, also, Chwastiak 1990 and Pownall 1986). Regarding the general feasibility of the two strategies, the consensus was that the potential for both clearly exists. The CASB standards allow employee transfers (which occur routinely for various reasons) as long as the amounts of pension assets and liabilities transferred are justified on an actuarial basis. Similarly, there are no obvious reasons why defense contractors would be unable to implement the two variants of the across-time strategy. While they do not use the across-contract/across-time terminology, Finston and Mehr (1986, chap. 13) and some of the cases described in the Comptroller General's report (GAO 1977) illustrate how firms implement these strategies. For example, firms can disguise across-plan transfers by delaying employee transfers until retirement (only bookkeeping transfers are required) and by combining transfers with corporate restructuring.

If the potential to implement the hypothesized strategies exists, why don't the various watchdog groups prevent such behavior? One explanation is that the DOD adjusts the contract price suitably in each case to negate the effects of these strategies.[7] A very different explanation is that the limited resources of these groups are focused on cases that involve less subtle strategies. Unlike cases where costs are inflated by including nonexistent costs or by transferring costs that clearly belong to non-defense activities, the pension costs described here relate to documented cash outflows for workers currently employed on defense contracts. As a result, the DOD faces considerable difficulty in reclaiming its share of any overfunding (see, e.g., the Comptroller General's report and recent cases involving reversions of excess pension assets from proposed plan terminations by defense contracts).[8]

Predictions

While all strategies predict that defense contractors will be overfunded *on average* (relative to base funding levels) and use more conservative actuarial variables, there are differences in the predictions for cross-sectional variation in funding levels and actuarial variables *across defense firms*, based on the proportion of defense revenues (inter-firm predictions). Also, the different strategies have different predictions for

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nominal discount and wage growth rates (that include inflation) for one plan and use a set of real rates (that exclude inflation) for another plan.

[7] This explanation would require a substantial amount of monitoring by the DOD to ensure equity across contracts. Given such adjustments, the incentives for contractors to engage in these strategies are unclear.

[8] In addition to the debate over whether the parties making the contributions (here, firms and the DOD) "own" the excess assets (as some portion might belong to the workers), determining how much of the current excess is due to pension contributions from cost-reimbursed contracts (as opposed to other activities or unexpectedly high returns from pension asset investments) is a difficult issue; e.g., see Genral Dynamics' 1987 annual report (p. 37), a description of Loral's acquisition of Ford's aerospace division in *The New York Times* (16 August, 1990, D2), and a report on the intended acquisition of Lockheed by Harold Simmons in *Forbes* (5 February, 1990, 42). We thank Jody Magliolo for these examples.

variation in the distributions of funding levels and actuarial variables across plans sponsored by each firm (intra-firm predictions). Note that the funding level is a "stock" variable that reflects the cumulative effect of prior funding patterns.

For firms using the across-contract strategy, the relation between funding levels and the percentage of revenues from defense contracts (%DOD) should be represented by an inverted *U*. As %DOD increases (starting from zero), *overall* funding levels (across all plans sponsored by each defense contractor) are expected to increase, because of the greater influence of the fully funded defense plans. Since individual plans are constrained by maximum funding limits (under tax and CASB rules), firms with lower %DOD attain lower overall funding levels than firms with higher %DOD. This positive relation between overall funding levels and %DOD is expected as long as there is sufficient leeway for transfers of employees and pension assets and liabilities between defense and non-defense plans. To illustrate, take the extreme case of a contractor whose revenues are entirely from defense contracts (%DOD = 100%); without non-defense plans, the contractor would be unable to implement the transfers called for by the across-contract strategy and would thus not overfund the defense plans. This trade-off between the potential to overfund as there is more defense business and the availability of sufficient non-defense business to implement the transfers is the basis for our prediction of an inverted-*U*-shaped relation (i.e., firms with intermediate values of %DOD are expected to be funded at the highest overall levels).[9]

Firms using the across-time strategy would exhibit a positive cross-sectional relation between funding levels and %DOD. With defense plans funded to the maximum allowed, the aggregate funding levels (across all plans) would be higher for firms with a greater proportion of defense contracts.[10]

Turning to the intra-firm predictions, firms using the across-contract strategy are expected to exhibit bimodal distributions for funding levels and actuarial variables, with defense plans having higher funding levels and more conservative actuarial variables. One reason firms might sponsor many plans for their defense and non-defense business, rather than one plan for each sector, is to conceal obvious evidence of systematic differences between the two sectors. Similar intra-firm predictions arise for firms using the plan-wise variant of the across-time strategy: many plans would be sponsored and the group of plans currently operating on defense contracts would exhibit higher funding levels and more conservative actuarial variables. In contrast, there is no reason why firms using the firm-wise variant of the across-time strategy should sponsor more than one plan or exhibit intra-firm differences in funding levels and actuarial assumptions.

II. Empirical Tests

Funding data at the firm level, reported in footnotes to financial statements subsequent to SFAS No. 36 (FASB 1980), are obtained from the SFAS No. 36 tape (Columbia

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[9] These predictions are fairly general. We are unable to predict the exact intermediate value of %DOD at which funding levels are expected to peak. We are also unable to predict whether the peak is gradual or sudden, i.e., whether the relation looks like an inverted-*U* or an inverted-*V*.

[10] This prediction is based on the assumption that %DOD (current proportion of defense business) is unrelated to the probability that the firm will switch to non-defense business in the future (see fn. 5). If, for example, %DOD is negatively related to the probability of a switch, then the predicted relation between funding level and %DOD would be represented by a nonlinear relation resembling that predicted by the across-contract strategy.

University). This database contains pension assets, liabilities, and assumed interest rates for 1,524 large firms (with inventories and gross fixed assets exceeding $125 million or total assets exceeding $1 billion). This firm-level pension data is collected from annual reports for the period 1980–83. Plan-level pension data, provided in Form 5500 reports subsequent to ERISA in 1974, are obtained from the Department of Labor (DOL) tapes. The actuarial data required for our plan-level tests, from Schedule B of Form 5500, were provided in the DOL tapes only after 1980. Given the difficulty of matching plans on these tapes with firms (see Thomas 1988), we use only one year of data—from the 1981 tape. Financial data are obtained from the 1984 edition (20 years of data up to 1983) of the COMPUSTAT annual industrial file.

A sample of major defense contractors is identified from the annual DOD publication *100 Companies—Companies Receiving the Largest Dollar Volume of Military Prime Contract Awards* (DOD), Directorate for Information Operations and Reports, The Pentagon, Washington, D.C.). Since military contracts generate revenues over many years after the contract is awarded, we use five annual lists to obtain a more representative measure of revenues from defense contracts; the five-year period 1975–79 was chosen so that the end of the period coincided with the beginning of the period used to compute funding levels (1980–83). Firms on these lists account for more than 65 percent of the value of all DOD contracts awarded during this period.

The initial sample of defense contractors consisted of 74 firms from the five annual DOD lists that also were included on the COMPUSTAT annual industrial file and had funding data on the SFAS No. 36 database. Examination of the distribution of %DOD for this sample indicated that only nine firms had %DOD greater than 30 percent, since the sample included many large firms (like AT&T, IBM, and the oil companies) with defense revenues that are large in magnitude but small as a percent of total revenues. To include more high %DOD firms, we identified all firms on the SFAS No. 36 database from the following six Standard Industrial Classification (SIC) defense industries: 3720, 3721, 3724, and 3728 (aircraft); 3730 (shipbuilding); and 3760 (missiles). After eliminating firms already in our initial sample, we searched the annual reports and 10-K forms between 1975 and 1979 for the remaining firms to identify data on sales to the U.S. government. For these firms, we assume that all U.S. government revenues related to defense contracts. We identified six firms with at least one year of available data, of which three had %DOD in excess of 30 percent. Thus, the final sample consisted of 80 firms.

For comparison purposes, we also identified a control sample of 80 firms unlikely to be associated with cost reimbursement. To obtain the control sample, we deleted all defense firms (from the five DOD lists and the six four-digit SIC industry groups noted earlier) and public utilities, because utility firms could also face some form of cost reimbursement, from the list of firms on both the COMPUSTAT and SFAS No. 36 databases. Public utilities are defined as firms in the following eight four-digit SIC groups: 4811 (telephone); 4911 (electric); 4922, 4923, and 4924 (gas); 4931 and 4932 (combined); and 4940 (water). From the remaining firms, we identified a non-defense firm with the closest value for total assets in 1981 for each defense firm. This control for size is designed to obtain a sample with a similar number of plans per firm for reasons mentioned in the intra-firm analysis at the end of this section.

Distribution of Funding Levels for Defense Contractors

Before examining the specific inter- and intra-firm predictions of the various strategies, we describe funding levels for the defense sample. A general prediction for all strategies is that funding levels for defense firms exceed base levels that would arise in the absence of cost reimbursement. To estimate base funding levels, we use two pension variables and six financial factors identified by prior research as related to funding levels. These variables are described briefly below; for details on why these variables might be important, see Bodie et al. (1987), Francis and Reiter (1987), and Thomas (1988).

The pension variables used are measures of plan maturity (PLNMATUR) and pension bonds (BENEMPL). Details of the definitions for all variables used (and the related data sources) are provided in appendix B. Plan maturity, represented by the ratio of vested benefits to total benefits, measures the demographics of plan participants; the lower this ratio, the greater the proportion of recently hired employees covered. The second variable, proxying for the magnitude of the implicit pension bond created by unfunded pension promises, is measured by the ratio of total pension benefits to total employees. As with the measure of funding level, the median of all available data between 1980 and 1983 is used for these two pension variables.

Since actuarial procedures tend to smooth changes in funding, current funding levels reflect prior years' effects. Thus, ten years of data (from 1971 to 1980) are used to construct the variables proxying for financial effects, as in Francis and Reiter (1987) and Thomas (1988). The first financial variable, tax status (TAXDUM), is coded as a dichotomous measure. A low tax status is expected to cause lower funding levels and is indicated by the presence of at least two tax loss carryforwards over the ten years; all other firms are classified as high tax status firms. The second and third variables, leverage and profitability, are measured by the ratio of debt to assets (D/A) and the ratio of operating income before depreciation, interest, and taxes to total assets (PM). Two other measures of profitability, which focus on net funds flows, are used to remove accruals included in accounting income. One is based on net working capital flows from operations (WCF), scaled by total assets, to adjust for non-current accruals (such as depreciation). The other, based on net operating cash flows (CFL), scaled by total assets, also adjusts for current accruals (changes in current assets and current liabilities). The last financial variable used is the logarithm of sales (LOGSALES) which is included to control for size effects. Median values over the ten years are used for all financial variables except the first, TAXDUM.

The measure of funding used, standardized funding level (SFL), is the ratio of pension assets to accumulated pension obligations (both vested and non-vested), standardized to a common discount rate (S) obtained from the PBGC. Standardization of pension liabilities improves comparability across reported liabilities that use different discount rates (R), which vary across firms and over time. Since many firm years on the SFAS No. 36 database had missing data for at least one of the inputs required to compute SFL, we used the median of all available SFL values on the database (between 1980 and 1983) rather than the values for any one year, to reduce the number of firms excluded from the analysis.

Table 1
Comparison of Pension Funding Between Defense and Non-Defense Samples (For 80 Major Defense Contractors and 80 Non-Defense Firms of Similar Size)

Explanatory Variable	*Estimate* (*p-value*)
Intercept	1.82 (0.00)
TAXDUM	0.05 (0.50)
D/A	0.51 (0.09)
PM	1.16 (0.24)
CFL	1.19 (0.41)
WCF	1.25 (0.60)
LOGSALES	−0.08 (0.00)
PLNMATUR	−0.53 (0.26)
BENEMPL	−0.01 (0.00)
DODDUM	0.21 (0.00)
Adjusted $R^2=0.32$	

The variables are defined as follows (see app. B for additional details):

SFL = standardized funding level, ratio of pension assets to accumulated pension obligation (standardized to PBGC discount rate);
TAXDUM = tax status measure, coded 0 if at least two tax loss carryforwards were disclosed over the past ten years, and 1 otherwise;
D/A = leverage measure, ratio of total debt to total assets;
PM = profitability measure, ratio of operating income to total assets;
CFL = cash flows, ratio of cash flow from operations to total assets;
WCF = working capital flows, ratio of working capital from operations to total assets;
LOGSALES = measure of size, logarithm of total sales;
PLNMATUR = measure of plan demographics, ratio of vested benefits to total benefits;
BENEMPL = measure of pension bond, ratio of total benefits to total employees; and
DODDUM = 1 for defense sample and 0 for control non-defense sample.

Median values over the period 1971–80 are used for the financial variables (D/A, PM, CFL, WCF, and LOGSALES) and median values over the period 1980–83 are used for all pension variables (SFL, PLNMATUR, and BENEMPL). All p-values are based on two-tailed tests. The measure for size used to select non-defense firms is total assets in 1981.

The mean and median standardized funding level for the defense sample is 1.38, which indicates that pension assets are 138 percent of standarized accumulated pension liabilities. Recall that many firms in the defense sample are not primarily defense contractors. The SFL values for firms in the six defense industries (a total of 21 firms from the SFAS No. 36 database) are higher, as indicated by a mean and median of 1.48 and 1.41. The 162 firms in the eight utility industries exhibit even higher funding levels; mean and median SFL are 1.58 and 1.50. In contrast, the 80-firm control sample has a mean and median SFL of 1.33 and 1.36, and the mean and median SFL for all other firms on the SFAS No. 36 database (a total of 1,030 firms) are 1.37 and 1.33. Although these results suggest that firms associated with cost reimbursement have higher funding levels than firms that do not, comparisons of funding levels need to control for other factors that also influence funding levels.

One alternative is to compare funding for the 80-firm defense and non-defense samples by estimating a regression of standardized funding level on the various control variables and using an intercept dummy (DODDUM) to capture the differential funding for defense firms. The results of such a regression, reported in table 1, indicate a significant positive coefficient on DODDUM equal to 0.21. After controlling for various factors that are known to influence funding levels, defense firms are, on average, funded 21 percent (as a percent of standardized liabilities) higher than non-defense firms.

The regression estimated in table 1 assumes that the control variables affect defense and non-defense firms in the same way. Allowing the variables to have separate effects on the two samples, by introducing slope dummies for each variable, results in a coefficient on DODDUM equal to 0.47, even higher than that in table 1 (other details of the regression results are not reported). Overall, these comparisons suggest that cost reimbursement creates incentives to overfund relative to base funding levels that would be obtained in the absence of cost reimbursement. While this result is generally consistent with the hypothesized strategies discussed in section I, it does not help to distinguish between the hypothesized strategies. The tests that follow analyze specific predictions of these strategies relating to inter- and intra-firm variation among defense firms.

Inter-Firm Variation in Funding Levels Among Defense Sample

The explanatory variable used to examine cross-sectional variation across defense firms, %DOD, is defined as the ratio (expressed as a percentage) of the cumulative dollar value of defense contracts awarded over the five-year period 1975–79 to total revenues over the same period.

The first column in table 2 provides a simple description of the cross-sectional relation between standardized funding levels (SFL) and the mix of defense and non-defense revenues (%DOD). The null hypothesis of no relation between funding levels and %DOD predicts zero values for both coefficients, the across-time strategy predicts a positive (zero) coefficient on %DOD ($\%DOD^2$), and the across-contract strategy predicts a positive (negative) coefficient on %DOD ($\%DOD^2$) corresponding to the predicted inverted-*U*-shaped relation. The significant positive and negative values of the estimated coefficients on %DOD and $\%DOD^2$ reject the null hypothesis, and the significant negative $\%DOD^2$ coefficient rejects the across-time strategy. Only the across-contract strategy is consistent with the signs of both coefficients.

Figure 1 is a graphical representation of this non-linear relation between funding levels and the mix of defense and non-defense revenues. Funding levels are positively (negatively) related to %DOD at lower (higher) values of %DOD, and the highest funding levels are observed for firms with intermediate levels of defense revenue. The exact shape of the inverted-*U*-shaped relation estimated by the regression (in the first column of table 2) can be obtained by substituting different values of %DOD and obtaining the SFL value corresponding to that %DOD. Funding levels increase from 1.23 at $\%DOD = 0$, reach a maximum of 1.70 near $\%DOD = 50$ percent, and then decline to a value of 1.24 at $\%DOD = 100$ percent.

It is important to note that only a few high %DOD firms are represented in the sample. Although the coefficient on $\%DOD^2$ is statistically significant, the downward sloping portion of the relation is based on a relatively small proportion of the sample. Unfortunately additional firms with high %DOD are not easily located.

Even though these preliminary findings support the across-contract strategy, some questions remain. First, the funding levels examined should be relative to base funding levels that are expected without cost reimbursement; that is, the effects of the control variables in table 1 should also be incorporated. The relation reported in the first column of table 2 and figure 1 might be spurious if these omitted variables are correlated with %DOD or $\%DOD^2$. Second, no direct evidence of defense contractors setting

Table 2
Cross-Sectional Relation Between Pension Funding and Defense Revenue (For 80 Major Defense Contractors)

Explanatory Variable	*Excluding Control Variables* *Estimate (p-value)*	*Including Control Variables* *Estimate (p-value)*	*(Adjusted p-value)*
Intercept	1.23 (0.00)	2.08 (0.00)	—
TAXDUM	—	0.02 (0.81)	(0.78)
D/A	—	−0.21 (0.63)	(0.56)
PM	—	1.60 (0.30)	(0.22)
CFL	—	4.33 (0.02)	(0.01)
WCF	—	−3.27 (0.30)	(0.28)
LOGSALES	—	−0.03 (0.46)	(0.37)
PLNMATUR	—	−0.69 (0.32)	(0.51)
BENEMPL	—	−0.02 (0.00)	(0.00)
%DOD	1.85×10^{-2} (0.00)	1.71×10^{-2} (0.01)	(0.00)
%DOD^2	-1.84×10^{-4} (0.01)	-1.50×10^{-4} (0.01)	(0.00)
	Adjusted $R^2=0.09$	Adjusted $R^2=0.43$	

The variables are defined as follows (see app. B for additional details):

SFL = standardized funding level, ratio of pension assets to accumulated pension obligation (standardized to PBGC discount rate);
TAXDUM = tax status measure, coded 0 if at least two tax loss carryforwards were disclosed over the past ten years, and 1 otherwise;
D/A = leverage measure, ratio of total debt to total assets;
PM = profitability measure, ratio of operating income to total assets;
CFL = cash flows, ratio of cash flow from operations to total assets;
WCF = working capital flows, ratio of working capital from operations to total assets;
LOGSALES = measure of size, logarithm of total sales;
PLNMATUR = measure of plan demographics, ratio of vested benefits to total benefits;
BENEMPL = measure of pension bond, ratio of total benefits to total employees; and
%DOD = percent of total revenues from defense contracts (median between 1975–79).

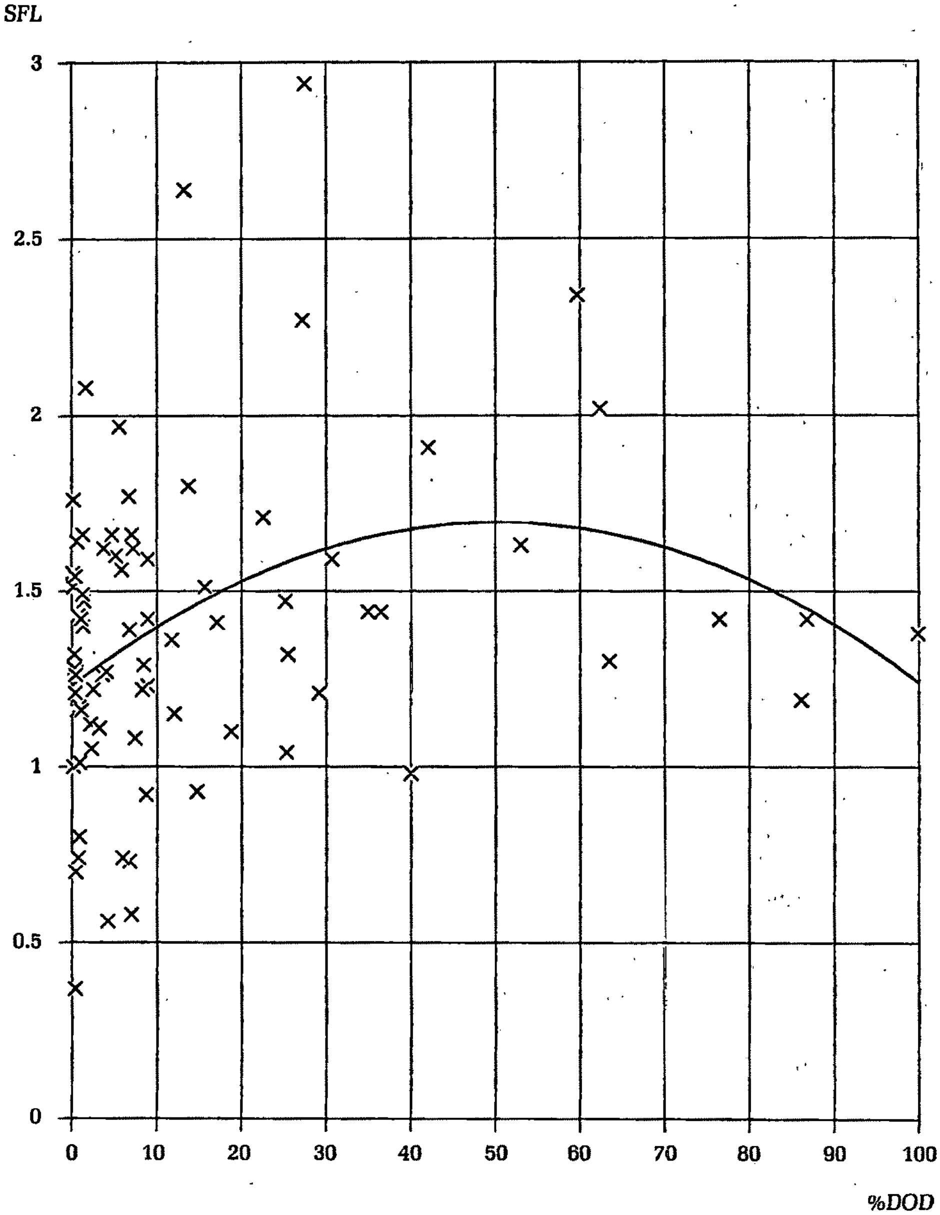
Median values over the period 1971–80 are used for the financial variables (D/A, PM, CFL, WCF, and LOGSALES) and median values over the period 1980–83 are used for all pension variables (SFL, PLNMATUR, and BENEMPL). All p-values are based on two-tailed tests, except for %DOD and %DOD^2 which are based on one-tailed tests. The adjusted p-values are based on the White (1980) heteroskedasticity corrections.

up separate plans for defense and non-defense business and making transfers between these plans has been provided. The subsection that follows reports (1) results obtained by including the control variables in the basic regression, as well as some sensitivity analysis, and (2) an examination of plan-level data for indirect evidence on the transfers between plans.

Controlling for Confounding Effects and Sensitivity Analysis

Including the two pension and six financial control variables discussed earlier does not alter the inverted-U-shaped relation between funding levels and proportion of defense revenue (compare the first and second columns in table 2). The coefficients on %DOD and %DOD^2 are both very significant and of approximately the same magnitude as those obtained without the control variables. Note that although many of the control

Figure 1
Standardized Funding Level (SFL) versus Percent of Revenues from Defense Contracts (%DOD)



Note: See appendix B for details of variables used.

variables are not important separately in explaining variation in funding levels (only BENEMPL and CFL are statistically significant at the 5 percent level), together they explain a substantial amount of variation, as the adjusted R^2 increases from 0.09 to 0.43.

Examination of the bivariate correlations between the variables (results not reported) indicates that all explanatory variables except TAXDUM and D/A are significantly related to funding levels. As mentioned earlier, the high degree of correlation among the explanatory variables reduces the ability to identify the separate effects of individual explanatory variables. Since the statistical significance of individual estimated coefficients on the control variables are not examined, potential biases in the estimated standard errors for the control variables are not a concern here; the only concern is whether multicollinearity affects inferences regarding the two %DOD variables. While the many cases of significant correlation between %DOD and the control variables suggest that this may be a concern, sensitivity analysis (discussed later) indicates that the standard errors on the two %DOD variables are not seriously affected by multicollinearity.

Summarized below are the results of a substantial amount of sensitivity analysis and diagnostic checks that were conducted on the sample (details are available upon request).

- Diagnostic procedures from SAS (1990) are used to identify the effects of multicollinearity, heteroskedasticity, and outliers. Although multicollinearity is a serious problem for inferences regarding some of the control variables, it does not degrade the standard error estimates for the two %DOD variables, on the basis of condition indices per Belsley et al. (1980). The joint null hypothesis of homoskedastic errors and a correctly specified model is rejected at less than the 1 percent level on the basis of the test proposed by White (1980). The adjusted *p*-values for the estimated coefficients (based on White's procedures) are reported in the third column of table 2, and the overall results remain unchanged. A study of outliers, based on Belsley et al. (1980), suggests the absence of influential outliers. In fact, deleting the three observations with values of $DFFITS_i$ exceeding one has the effect of *increasing* R^2 (to 0.51) and making the %DOD coefficients even more significant.
- Replacing the %DOD measure used above with the mean or median values of the five annual ratios of defense contracts awarded to total revenues (from 1975 to 1979) does not alter any of the inferences in table 2. This is not surprising given that the three measures of %DOD are highly correlated (Pearson and Spearman correlations exceed 0.96 for all pairwise comparisons).
- Using the SFL values for only one year at a time, instead of the median of all available SFL values between 1980 and 1983, does not change the basic results. We conducted this analysis for two years with the least number of missing SFL values: 1981 and 1982.
- The regression results for the two %DOD variables are not altered materially when the ten-year median values of the financial control variables (all except TAXDUM) are replaced by the ten-year means. Also, when using one year's SFL values at a time, we repeated the analysis with the prior year's financial data (instead of the prior ten years' data), and the basic results were not affected.
- Deleting the six firms not in the top 100 contractors list (since their %DOD values are likely to be more noisy than for the rest of the sample) did not change the basic results.

Intra-Firm Variation in Funding Variables

To review the intra-firm predictions, the predictions of both the across-contract strategy and the plan-wise variant of the across-time strategy are that defense contractors will sponsor more plans than other firms to (1) maintain separate plans for defense and non-defense business, and (2) disguise the systematic overfunding and withdrawal required by these strategies. With both these cases, defense contractors are also predicted to select different funding levels and actuarial variables for defense and non-defense plans, which results in greater dispersion of funding variables across plans sponsored by each contractor. No specific intra-firm predictions are available for the firm-wise variant of the across-time strategy.

Since the information in Form 5500 reports does not allow a separation of defense and non-defense plans, we are unable to contrast funding variables across the two types of plans. We are, however, able to compare the variation in funding variables across plans for each defense firm with that for each non-defense control firm. A defense firm that funds its defense plans differently from its non-defense plans should exhibit greater variation in funding variables than a control firm. We use the range of each funding variable, the difference between the highest and lowest value, as a measure of variation for each firm. Alternative measures of variation, such as the standard deviation, are inappropriate because of the many firms with relatively few plans with data available for the various funding variables.

Since variation in funding variables is likely to be positively related to the number of plans sponsored by each firm, it is important to control for factors that cause firms to sponsor more plans when selecting non-defense firms. A major reason firms sponsor multiple plans is to offer different pension benefits to different employee groups. The plan-design literature (see, e.g., McGill 1984) suggests that factors such as the extent of unionization, the presence of different bargaining units, and the acquisition of other divisions and firms are possible reasons for separate plans for different groups. We use firm size to proxy for these effects and select for each of the 80 defense firms a control non-defense firm with the closest value for total assets in 1981.

Since pension plans on the DOL database are not directly linked to the corporate entities on COMPUSTAT, moving from firm-level to plan-level analyses requires considerable effort to identify all plans on the DOL database sponsored by each corporate entity. Each corporation may have several subsidiaries and divisions, and each parent or subsidiary or division may sponsor several plans. The following steps were used to relate plans to consolidated entities. First, all subsidiaries and divisions were identified through the *Standard & Poor's Register of Corporations, Directors and Executives*. Second, all plans on the DOL database with assets exceeding $1 million and with actuarial and funding information in Schedule B of Form 5500 were identified to obtain a reasonably sized subset that could be scanned manually for plans sponsored by parents, subsidiaries, and divisions of sample firms. Finally, these plans' Employer Identification Numbers (EIN) were noted and used to retrieve data for all pension plans on the DOL database with the same EIN.

The three funding variables examined are: (1) the standardized funding level (SFL); (2) the discount rate used for funding purposes, FR; and (3) the conservatism of the actuarial method (AM). The two acturial assumptions, AM and FR, influence funding patterns by influencing the *actuarial* liability. More conservative (lower) assumed values of FR increase the actuarial liability and require faster funding (resulting in higher plan assets and higher SFL) than less conservative assumptions. Unlike FR, however, only a categorical measure is available for AM: it is coded as zero for unit credit, one for entry age normal, and two for all other methods. More conservative actuarial methods, represented by higher coded values of AM, result in higher funding levels.

Analysis of the actuarial variables, FR and AM, provides a different perspective than that obtained from the SFL comparisons. SFL could vary across plans sponsored by the same firm for a number of reasons (such as investment performance and unexpected inflation), not all of which can be controlled by the sponsor. Both FR and AM, however, are selected by the sponsor. Thus, greater intra-firm variation in FR and AM for the defense sample is a less ambiguous indication of intra-firm variation in *desired* funding levels, compared to the intra-firm variation in *observed* funding levels (SFL).

The results shown in the first panel of table 3 confirm that defense contractors sponsor more plans than firms in the control sample. The mean number of plans sponsored by each firm in the defense contractor sample is 10.14, and the median is 6. Both values are more than twice the corresponding numbers for the control sample. Both the *t*-test (conventional ANOVA) and the rank-sum test (equivalent to a *t*-test based on ranks; see PROC NPAR1WAY, SAS [1990]) reject the null hypothesis that the distributions of the number of plans per firm are similar for the two samples. There are, however, other reasons why defense contractors might sponsor more plans; for example, they might sponsor separate plans for their defense business purely for bookkeeping convenience (to allow them to separate the two sets of pension costs easily). The remaining tests confirm that, in addition to sponsoring more plans, defense contractors exhibit more intra-firm heterogeneity in funding levels and actuarial variables.

The results shown in the second panel of table 3 indicate that defense contractors exhibit more variation in funding levels (SFL) across plans sponsored by each firm. The mean (median) value of the difference between the highest and lowest SFL for each firm is 1.27 (1.15). Both values are significantly higher than the corresponding mean and median of the *ranges* for each firm in the control sample. To confirm that the plans examined (those with data on the DOL tape) were not an insignificant fraction of all plans sponsored by sample firms, we computed the ratio of the sum of plan assets (for all plans on the DOL tape) to the total assets (from the SFAS No. 36 database). The mean (median) ratio of 0.90 (0.91) and 0.87 (0.89) for the defense and control samples suggests that very few of these firms' plans were excluded.

In the third panel of table 3, we report results from an examination of intra-firm variation in the discount rate assumed for funding purposes (FR). The mean and median ranges of 1.11 and 0.50 percent for the defense sample are significantly higher than the corresponding values for the control sample. Although the differences do not seem substantial in absolute value, it should be noted that even small differences in FR have a large effect on funding. For example, a change of 1 percent in this rate can reduce funding for a typical plan by 25 percent (McGill 1984). The bottom panel in table 3 provides results from an examination of intra-firm variation in the conservatism of the actuarial method used (AM). Again, the defense sample exhibits significantly more intra-firm variation than the control sample. Unlike the FR analysis, the mean and

Table 3

Comparison of Intra-Firm (Across Plan) Variation in Funding Variables (For 80 Major Defense Contractors and Size-Matched Control Firms, 1981 Data)

Variable Analyzed	*Statistic*	*Defense Sample*	*Control Sample (Matched on Total Assets)*	*p-value for Test of Difference*
Number of plans sponsored by each firm	Mean	10.14	4.92	(0.00)
	Median	6.00	2.00	(0.00)
		(n=73)	(n=61)	
Max. SFL–min. SFL across plans sponsored by each firm	Mean	1.27	0.64	(0.00)
	Median	1.15	0.43	(0.00)
		(n=71)	(n=59)	
Max. FR–min. FR across plans sponsored by each firm	Mean	1.11	0.48	(0.01)
	Median	0.50	0.00	(0.01)
		(n=73)	(n=60)	
Max. AM–min. AM across plans sponsored by each firm	Mean	1.11	0.49	(0.02)
	Median	1.00	0.00	(0.02)
		(n=73)	(n=61)	

The variables are defined as follows (see app. B for additional details):

SFL = standardized funding level, ratio of pension assets to accumulated pension obligation (standardized to PBGC discount rate to correct for cross-sectional differences in reported discount rates);
FR = discount rate assumed for actuarial funding purposes; and
AM = conservatism of actuarial method, coded 0 for unit credit, 1 for entry age normal, and 2 for all others.

The p-values in the mean and median rows relate to one-tailed *t*-tests and rank-sum tests.

median values of the AM range have no economic interpretation, as they are a function of the coding procedures used. Examination of comparisons based on two alternative coding procedures suggest that the observed differences are not driven by the trichotomous coding used here.[11] Given the nonnormal distribution of the AM ranges, the results of the *t*-test should be interpreted with caution.

While no single result reported in table 3 is conclusive by itself, the combined results create a portfolio effect that increases the likelihood that the observed patterns are caused by the hypothesized strategies. There are other explanations for why defense contractors might sponsor more plans, and perhaps the greater heterogeneity in funding levels is due entirely to there being more plans. However, the evidence on defense contractors selecting different actuarial methods and assuming different rates to discount future benefits for plans sponsored by the same firm point to a clear desire to fund these many different plans at different levels.

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[11] First, we classified all methods into two groups: benefit allocation methods (unit credit) and cost allocation methods (all others). As an alternative classification, we separated the individual level premium method from the "all others" category in table 3 (code = 2) and classified it as being the most conservative (code = 3) to get four groupings for AM. In both cases, the differences between the samples remain highly significant.

III. Conclusions

This article extends the literature on the determinants of pension funding by showing that funding levels are related to defense revenues. More important, this study offers three new findings on the incentives for firms operating under cost reimbursement. First, our analysis suggests that there is little incentive to overfund under cost reimbursement if the contractor does not also engage in other activities for which costs are not reimbursed. Whether these other activities are undertaken concurrently or at a different point in time has different implications for the appropriate strategy to be employed (across-contracts vs. across-time), but in either case the firm overfunds when costs are reimbursed and withdraws these excess pension assets when costs are not reimbursed. Second, defense contractors are overfunded, on average, relative to a standardized measure of the accumulated pension obligation and to a base liability that adjusts for general factors that influence pension funding. More important, the relation between overfunding and the proportion of revenues from defense contracts is represented by an inverted-*U*. At lower proportions of defense revenues, the two variables are positively related, but they are negatively related for higher proportions of defense revenues. Finally, defense contractors sponsor more plans and exhibit more intra-firm variation in funding levels, actuarial methods, and assumed discount rates, relative to a sample of control firms of similar size.

Although our anlaysis suggested two possible strategies that defense contractors could follow, the empirical results are consistent with the across-contract strategy alone. This strategy requires defense contractors to maintan separate plans for their defense and non-defense activities, overfund their defense plans, and periodically transfer employees along with their *pro rata* share of pension assets and liabilities between the two types of plans. Although data limitations prevent us from examining whether separate plans are sponsored and whether the hypothesized transfers actually occur, two general conclusions are possible: (1) the unusual inter-firm results (across defense contractors) suggest that funding levels for defense contractors are influenced by the proportion of non-defense business, and (2) the evidence of greater dispersion in actuarial assumptions and methods across plans sponsored by defense firms, relative to control non-defense firms, suggests that defense contractors seek to fund their plans at very different levels. Despite the evidence on differences in funding behavior across defense contractors and between defense contractors and other firms, this study does not address the issue of whether these hypothesized strategies result in the contractors earning abnormal profits by overcharging the government.

Appendix A

Incentives to Overfund for Varying Levels of Cost Reimbursement

We examine here the effects of defense contractors overfunding their defined benefit plan when costs are reimbursed. The contractor is reimbursed $\mathbf{x}$ dollars by the DOD for each additional dollar contributed to the pension fund. Since the contribution generates a tax deduction of one dollar, additional taxes paid equal $(\mathbf{x}-\mathbf{1})\tau$, where τ is the current marginal tax rate (at $t=0$) when the overfunding occurs. The net cash flow is then $(\mathbf{x}-\mathbf{1})(1-\tau)$, as illustrated in figure A1.[12]

Since the actual benefits paid are not affected by levels of overfunding, by assumption, the additional dollar of overfunding needs to be withdrawn (at $t=\mathbf{n}$) along with any interest that accrues at the rate $\mathbf{r}$. Withdrawal of $(1+\mathbf{r})^n$ from the pension fund, effected by making lower contributions that year, reduces the reimbursement by $\mathbf{x}(1+\mathbf{r})^n$. As illustrated in figure A2, the net cash flows at $t=n$ are $(\mathbf{x}-\mathbf{1})(1+r)^n(1-\tau)$.

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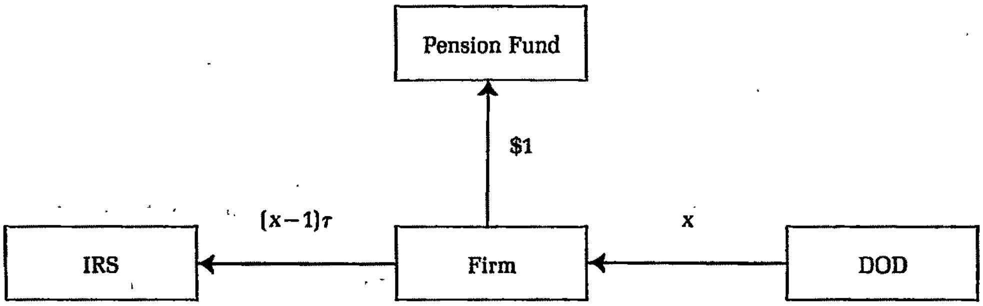
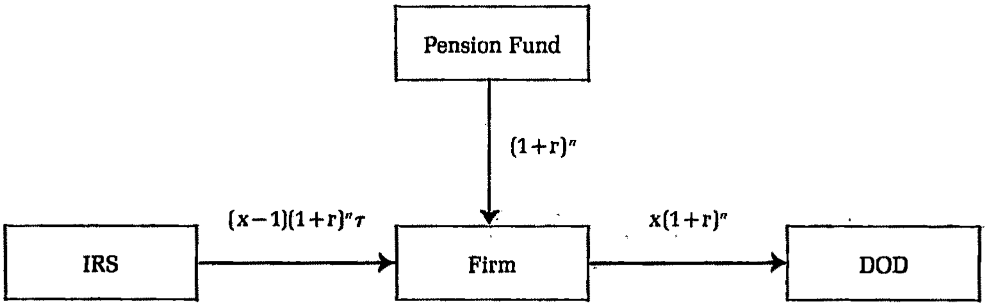
[12] Federal income taxes paid or accrued are not reimbursed for defense contracts. Although properly allocated state and local income taxes are reimbursed like other costs, we ignore these effects here. A more general analysis that allows for reimbursement of taxes produces the same basic results.

Figure A1



Pre-tax cash inflows: x
Pre-tax cash outflows: 1
Taxes paid: $(x-1)\tau$
Net cash inflows: $(x-1)(1-\tau)$

Figure A2



Pre-tax cash inflows: $(1+r)^n$
Pre-tax cash outflows: $x(1+r)^n$
Taxes saved: $(x-1)(1+r)^n\tau$
Net cash inflows: $(x-1)(1+r)^n(1-\tau)$

The main point is that the ratio of the net cash outflows at $t=n$ to net cash inflows at $t=0$ is $(1+r)^n$, when x and τ remain constant over time. If x is greater than or equal to 1, no outside financing is necessary. The DOD lends the contractor x dollars and recovers $x(1+r)^n$ dollars n years later. Given that the contractor could always borrow at the after-tax rate of interest (given the tax deductibility of interest on debt), there are no apparent advantages to borrowing from the DOD at the pre-tax rate, r. Note that actual interest costs are not reimbursed for defense contractors, who thus have incentives to obtain capital at the lowest possible costs.[13] If x is less than 1, the contractor needs to finance $1-x$ dollars and has available an amount of $(1-x)(1+r)^n$ dollars available to repay the principal and interest n years later. While this case is better than the previous one (where x is greater than or equal to 1), it is identical to the situation faced by firms without cost reimbursement (Tepper 1981). That is, cost reimbursement does not create unique incentives to overfund. An extension of the analysis that allows for x and τ to vary over time provides additional insights. The more the decline in x, the greater the benefits of overfunding. As described for the across-contract and across-time strategies, these benefits are maximized if x equals zero when the withdrawal occurs in year n. The effect of changing marginal tax rates is more complex: when x is less than 1, the benefits increase when marginal tax rates decrease; otherwise, the benefits increase as marginal tax rates increase.

[13] The cost of capital is, in general, not allowed for government contracts. The CASB does allow, however, an imputed interest cost for fixed assets and other facilities, including land (under CAS No. 414) and capitalization of interest for capital assets under construction (per CAS No. 417). In both cases, the costs allowed are based on rates published semiannually by the Secretary of the Treasury under PL 92-41, rather than the actual interest costs incurred by the contractor.

Appendix B
Description of Variables Used

Variable	*Description*	*Source*
Standardized funding level (SFL)	Median ratio, over 1980–83, of plan assets (A) to standardized accumulated obligation, which equals reported total benefits (TB) times ratio of reported discount rate, R, to the PBGC rate, S.	SFAS No. 36 tape and PBGC; $\frac{A}{TB} \times \frac{S}{R}$
Membership in defense/ control sample (DODDUM)	Coded 1 for firms in the defense sample, and 0 for firms in the control sample. The control sample consists of firms that are not on the DOD lists, not defense firms (SIC 3720, 3721, 3724, 3728, 3730, and 3760), and not utilities (SIC 4811, 4911, 4922, 4923, 4924, 4931, 4932, and 4940). Each defense firm is matched with a control firm closest in size, measured as total assets in 1981.	
Tax status measure (TAXDUM)	Measure of past marginal tax rates. Coded 0 for firms with low tax rates (indicated by at least two net operating loss carryforwards over 1971–80), and 1 otherwise.	COMPUSTAT; #52
Debt to assets (D/A)	Ratio of total debt to book value of assets (median over 1971–80).	COMPUSTAT; $\frac{\#9+\#5+\#75}{\#6}$
Profitability measure (PM)	Ratio of operating income before depreciation, interest, and taxes to book value of assets (median over 1971–80).	COMPUSTAT; $\frac{\#13}{\#6}$
Cash flows (CFL)	Ratio of cash flows from operations to book value of assets (median over 1971–80).	COMPUSTAT; $\frac{\#110+\Delta(\#5)-\Delta(\#4-\#1)}{\#6}$
Working capital flows (WCF)	Ratio of working capital flows from operations to book value of assets (median over 1971–80).	COMPUSTAT; $\frac{\#110}{\#6}$
Percentage of revenues from defense contracts (%DOD)	Ratio of the sum of defense contracts awarded (DR) over 1975–79 to the sum of total revenues (TR) over the same period.	DOD list of top 100 contractors for DR. COMPUSTAT; #12 for TR
Plan maturity (PLNMATUR)	Median ratio, over 1980–83, of vested benefits to total benefits (vested and non-vested).	SFAS No. 36 tape; $\frac{VB}{TB}$
Benefits per employee (BENEMPL)	Median ratio, over 1980–83, of reported total pension benefits to total employees (in thousands of dollars per employee).	SFAS No. 36 tape and COMPUSTAT; $\frac{TB}{\#29}$
Discount rate for funding (FR)	Rate used for actuarial purposes when determining contributions.	Schedule B, Form 5500 (from 1981 DOL tape).
Conservatism of actuarial method (AM)	Coded 0 for the unit credit method, 1 for entry age normal, and 2 for all others. (Higher AM implies a more conservative method.)	Schedule B, Form 5500 (from 1981 DOL tape).

Note: Data item numbers are indicated for COMPUSTAT data. All dollar amounts are in millions of dollars, except where noted.

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Constructing Incentive Schemes for Government Contracts: An Application of Agency Theory

Stefan Reichelstein
University of California, Berkeley

SYNOPSIS AND INTRODUCTION: In recent years, the agency paradigm has become central to theoretical research in managerial accounting. Empirical research in the area of executive compensation has tested the consistency of agency model predictions with observed compensation data.[1] However, it seems difficult to trace specific instances where results and insights obtained from agency models have affected actual management practice.[2] This article describes one such instance in the context of government contracting, showing how agency theory was used to design incentive contracts.

The research reported here was initiated by the German Department of Defense (GDOD). The Department commissioned a study to examine the applicability of a class of incentive schemes subsequently referred to as *budgeted-based schemes.*[3] To implement these schemes, the GDOD expressed interest in a constructive procedure that would derive suitable budget-based schemes for specific procurement projects. I describe such a

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[1] See, e.g., Lambert and Larcker (1987), Antle and Smith (1986) and Rosen (1990). Wolfson (1985) examines the extent to which sharing rules employed by oil and gas partnerships reflect agency problems.

[2] Johnson and Kaplan (1987, 175) express particular pessimism about the practical relevance of agency theory. They state that, "because of mathematical difficulties and the consequent lack of realism of the models and their assumptions, the potential for agency theory research to inform or even understand managerial accounting practice will likely be realized, if at all, only many years in the future."

[3] The budget-based schemes belong to the larger category of menus of linear contracts, studied extensively in the literature (see, e.g., Laffont and Tirole 1986; McAfee and McMillan 1987; Rogerson 1987; Melumad and Reichelstein 1989; Picard 1987; Baron and Besanko 1987, 1988). The models in those studies pertain to a variety of economic contexts, including procurement contracting, regulation, and performance evaluation of managers within firms.

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procedure and discuss a number of institutional factors that affected the way the budget-based schemes were applied to two pilot projects in Germany.

Traditionally, government contracts under sole-source conditions have been awarded either as fixed-price or cost-plus contracts. The use of fixed-price contracts has been confined to projects with relatively few technological and economic uncertainties. With such uncertainties, fixed-price contracts are unattractive from a risk-sharing perspective. Yet, even with a risk-neutral contractor (because of size and diversification) governments are typically reluctant to sign fixed-price contracts when there are major informational asymmetries. If the government is relatively ignorant about inputs and resources required for the project, it will have difficulties disputing the firm's *ex ante* cost calculation. As a consequence, the firm earns an informational rent; that is, the firm will extract a higher price than it would have if the government had shared the firm's knowledge and expertise.

Cost-plus contracts avoid the problem of overpayment, but, as has been well documented, the government subjects itself to the problem of cost padding. To limit the negative incentives of cost-plus contracts, it has become common practice in the United States to replace standard cost-plus contracts with cost-plus-fixed-fee contracts, so that the firm's profit allowance is fixed rather than being proportional to actual project costs.[4] In recent years, there has been an increasing trend in the United States to provide positive incentives for cost control by using cost-plus-incentive-fee contracts.[5] At the outset of a project, the parties negotiate a cost target, and the firm's profit increases proportionally with cost underruns relative to the cost target. Conversely, the incentive profit decreases at the same rate with cost overruns. In effect, the firm thus bears a share of actual project costs. A recent survey by the U.S. General Accounting Office (GAO 1987) shows that for the period 1978–84 firms' cost-share parameters typically varied between 15 and 25 percent, but were as high as 50 percent in unusual cases.

A major concern voiced repeatedly in connection with cost-plus-incentive-fee contracts is that the government is unable to formulate realistic cost targets for many projects. If the target is set unrealistically low, the firm is likely to suffer a financial penalty. Conversely, an unrealistically high cost target leads to additional "undeserved" profits. For this reason, the GAO states that cost-plus-incentive-fee contracts are confined to procurement projects where "the government has a sound basis to estimate contract costs, but where uncertainties exist that make a fixed-price contract impractical" (GAO 1987, 1). The relatively low cost-share param-

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[4] However, according to former Undersecretary of Defense R. Fox, generous provisions for reimbursement of "unusual" expenses create conditions that closely resemble standard cost-plus arrangements (see Fox 1974). In Germany, cost-plus-proportional-fee contracts are currently used, though with increasing controversy.

[5] McAfee and McMillan (1988) summarize the evolution of incentive schemes used by the U.S. Navy for shipbuilding contracts in the 1960s and 70s. In Germany, cost-plus-incentive-fee contracts have been used only for exceptional projects until recently.

eters currently used (15 to 25 percent) may reflect the government's desire to mitigate the effects of unrealistic cost targets.

The budget-based schemes considered in this study can be viewed as a refinement of cost-plus-incentive-fee contracts. In addition to actual cost, the incentive fee now depends as well on a cost estimate that the firm submits, typically at the start of the project. In effect, the firm selects a budget (target cost), and the incentive profit is proportional to the budget variance. Previous modeling analysis has shown that the budget-based schemes create desirable reporting and performance incentives (see Kirby et al. 1991). The government receives information that is useful for its budget planning process, since the contracting firm is induced to submit an unbiased cost estimate. Specifically, the firm has an incentive to reveal truthfully its own assessment of expected project costs. To some extent, the budget-based schemes therefore avoid the issue faced by cost-plus-incentive-fee contracts described above. Instead of having the government formulate a realistic cost target, this task is now left to the better informed firm.

From a cost-control perspective, the budget-based schemes have been shown to be optimal incentive mechanisms. By offering a menu of contracts, the government can tailor performance incentives to the firm's privately observed cost information.[6] Specifically, the firm chooses a high target profit in return for a high cost-share parameter, provided its cost information is relatively favorable. A high cost-share parameter will induce the firm to conduct the project in a more efficient way. The resulting cost savings are effectively split since the firm receives a large incentive profit. As a consequence, both sides will be better off.

Key Words: *Government contracting, Incentives, Agency theory.*

THE following section of this article contains a summary of the relevant incentive literature. In particular, I review the reporting and performance incentives created by the budget-based incentive schemes. A procedure that enables the government to constuct a suitable budget-based scheme for a given procurement project is described in section II. This procedure requires the government to assess a number of parameters reflecting the underlying agency problem and then carry out a sequence of computations to obtain the desired incentive contract.

Section III reports on applications of the budget-based schemes in Germany. The discussion first focuses on a number of modifications and constraints that representatives of the GDOD formulated in order to make the schemes compatible with current procurement policy. One budget-based scheme that is currently being used in a pilot project is described along with the criteria that led to its selection. Section IV concludes with a brief discussion of the potential use of budget-based schemes for regulating public utilities.

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[6] The advantage of a menu of contracts over a single incentive contract has been analyzed in the managerial accounting literature under the heading "value of communication" (see Baiman and Evans 1983; Melumad and Reichelstein 1989; Penno 1984).

I. Theory Background

Suppose that a government wants to conduct a project for which there is only one viable supplier (i.e., the government faces a sole-source contract). Frequently, both parties will be uncertain about the necessary cost for the project, yet the contracting firm has better cost information. In such cases, the government will typically use a cost-based contract. The project price then becomes the sum of actual costs incurred, as verified by the government's auditors, plus a profit allowance for the contracting firm. Under a *cost-plus-fixed-fee* contract, the firm's profit is a constant, yet it is a decreasing function of actual cost under a *cost-plus-incentive-fee* contract. With actual cost denoted by x, the price paid by the government can be expressed as:

$$P = x + H(x),$$

with,

$$H(x) = a + b \cdot (T - x). \tag{1}$$

The contractor's profit, $H(x)$, consists of a target profit a, plus a bonus (penalty) for cost underruns (overruns) relative to a prespecified cost target T. The parameter b $(0 \leq b \leq 1)$ is usually referred to as the cost share parameter. A cost-plus-fixed-fee contract results if $b = 0$.

In the present study, attention is restricted to incentive-fee functions of the form:

$$H(E, x) = a(E) + b(E) \cdot (E - x). \tag{2}$$

The contracting firm now determines the target cost through its estimate E. Deviations from this standard are rewarded or penalized at the rate $b(E)$, which itself depends on the firm's cost estimate. Similarly, it will be necessary to vary the target profit, $a(E)$, with the cost estimate in order to create appropriate reporting incentives. Effectively, the government offers a menu of contracts. By submitting its cost estimate the firm chooses one particular incentive fee function (linear in x) from the menu. Subsequently, the schemes in equation (2) will be referred to as *budget-based schemes*.

From the government's perspective, a menu of contracts may be preferable to a single incentive contract for two reasons. First, a menu may conceivably entail better performance incentives, that is, more effective incentives for cost control. Second, a menu of contracts allows the government to elicit cost information from the better informed firm. Ignoring the issue of cost control, it can be shown that the budget-based schemes induce the firm to provide an unbiased estimate of expected project cost, provided the functions $a(\cdot)$ and $b(\cdot)$ in equation (2) are suitably calibrated. Specifically, consider the following restrictions:[7]

$$a(E) \text{ is a convex and decreasing function and} \tag{3}$$
$$b(E) = -a'(E). \tag{4}$$

Suppose the firm subjectively assesses the expected project cost to be z.[8] If it reports E under a budget-based scheme, the expected profit becomes $a(E) + b(E) \cdot (E - z)$. In

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[7] If $a(\cdot)$ is not differentiable at E, then $a'(E)$ should be interpreted as a subgradient of $a(\cdot)$ at E.

[8] Formally, the firm's subjective beliefs regarding the uncertain cost x are represented by a probability distribution $F(\cdot)$ whose mean is z, i.e.,

$$z = \int x dF(x).$$

particular, the expected fee equals $a(z)$ if the true expectation z is reported. Incentive compatibility requires that:

$$a(z) \geq a(E) + b(E) \cdot (E - z), \tag{5}$$

for arbitrary values of z and E. After substituting equation (4) into equation (5), the self-selection condition becomes:

$$a(z) \geq a(E) - a'(E) \cdot (E - z) \geq 0, \tag{6}$$

which will be satisfied provided that the function $a(\bullet)$ is convex. It can be shown furthermore (see Osband and Reichelstein 1985) that the budget-based schemes are essentially unique in eliciting the mean of the privately known distribution $F(\bullet)$. To induce the same cost report for *all* distributions $F(\bullet)$ with mean z, the profit function must be linear in the actual cost variable x.[9]

Consider now the issue of performance incentives. There is a common perception that cost-based government contracts are subject to cost control problems. Firms may be tempted to pad project costs through expanded purchases of equipment, excessive testing and experimentation, or generous arrangements with their suppliers.[10]

It has been argued that the method for determining project costs can itself create undesired incentives. A major issue here is the application of overhead costs. Consider a situation where a govenment project and other commercial products share common production facilities. If overhead costs are allocated to the government project on the basis of direct labor hours, the firm may have an incentive to increase the number of direct labor hours for the government project, because direct labor costs are reimbursed and every hour of additional labor shifts overhead costs from the commercial products to the government contract.[11] Without countervailing incentive provisions, the firm will increase its profit by expanding the number of direct labor hours for the government project.[12] Rogerson (1992) develops a model that quantifies the distortions associated with overhead allocation rules commonly employed in defense contracting.

To model the possibility of cost padding, suppose the firm finds initially that the minimal expected project cost is μ. If the firm engages in the type of cost-increasing activities described above, it chooses a "slack" parameter $\alpha \geq 0$, with $\alpha = 0$ representing maximum efficiency. Since α measures the dollar amount of slack, it is natural to suppose that the expected project cost increases to $z=\mu+\alpha$. Actual cost, x, remains a random variable whose mean becomes $z=\mu+\alpha$. The firm's pecuniary benefit from incorporating slack is denoted by $B(\alpha)$, which represents the dollar value associated with slack level α.

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[9] Note that the budget-based schemes differ from the schemes examined by Weitzman (1976) in connection with a Soviet incentive system (Kaplan and Atkinson 1989 refer to them as "truth-inducing" schemes). Because the schemes discussed there consist of a menu of piecewise linear contracts, the informed agent (contracting firm) can be induced to report a given quantile of the distribution $F(\bullet)$ (e.g., the median). However, in general, such schemes cannot elicit the mean.

[10] Representatives of the German DOD mentioned the following specific cost padding problem. Suppose a contracting firm finds that it has hired too many workers. The firm can reduce its work force but then it will incur certain layoff costs, such as severance pay and social security payments. Alternatively, the firm can assign more workers than are actually needed to a government contract. Effectively, the firm pads the number of labor hours for the project, and is better off as long as project costs are fully reimbursed.

[11] This argument presumes that actual overhead costs do not increase "too fast" as direct labor hours increase.

[12] The same argument applies if the government adopts a normal costing format, i.e., direct costs are reimbursed at actual levels, while overhead costs are applied in proportion to some allocation base such as direct labor hours. If *actual* overhead costs increase at a rate less than the overhead application rate, the firm will be able to cover a larger share of its actual overhead cost by expanding the direct cost factors beyond the necessary level.

In designing an incentive contract, the government faces the following trade-off. Because the firm has better cost information (the parameter μ), stronger incentives for cost control can be obtained only at the expense of higher profit. As mentioned earlier, fixed-price contracts would induce perfect incentives to control project costs, yet the government is likely to overpay because the fixed price would be calculated so that the firm earns a minimum acceptable level of profit, even in case of high project costs. To balance the trade-off between stronger efficiency incentives and higher firm profits, it will be optimal in general to adopt an incentive scheme that results in a limited amount of slack.

Given any incentive contract, let $\alpha(\mu)$ denote the choice of slack that maximizes the firm's expected profit when its cost environment is μ. From the government's perspective, the optimal slack policy $\alpha(\mu)$ is determined by the benefit function $B(\bullet)$ as well as by prior beliefs regarding the firm's cost environment μ. Those beliefs are represented by a probability distribution function $N(\mu)$ with support $[\underline{\mu}, \bar{\mu}]$ and density function $n(\mu)$. A common assumption in models like the present one is that the "inverse hazard rate":

$$h(\mu)\equiv\frac{N(\mu)}{n(\mu)}$$

be monotone increasing.[13] The following result is taken from Kirby et al. (1991).

Lemma 1: If $h(\mu)$ is increasing in μ and the benefit function $B(\bullet)$ is concave with non-negative third derivative, then a budget-based scheme of the form shown in equations (2) through (4) is an optimal incentive contract.

The conditions of the lemma imply that an optimal incentive scheme induces a separation of types. Unlike low cost types (low μ), high cost types pad project costs to a larger extent (i.e., the function $\alpha[\mu]$ is increasing in μ).[14] The budget-based schemes in equations (2) through (4) induce exactly that separation since higher cost estimates imply lower cost-share parameters, which in turn means a lesser incentive to reduce slack. Given a budget-based scheme, the firm's expected payoff (i.e., profit plus benefit derived from slack), becomes:

$$a(E)+b(E)\bullet[E-(\mu+\alpha)]+B(\alpha). \tag{7}$$

The contracting firm seeks to maximize this expression with respect to α and E. Provided the budget-based scheme satisfies conditions (3) and (4) above, the firm will always report $E=\mu+\alpha$, regardless of the value of α to be chosen. Hence, whatever amount of slack, α, the firm chooses, it will provide an unbiased estimate of expected project costs. As a consequence, maximization of equation (7) reduces to maximizing

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[13] This condition is satisfied by many of the commonly considered probability distributions (see, e.g., Laffont and Tirole 1991 and the references contained therein).

[14] This result has been established by Laffont and Tirole (1986), McAfee and McMillan (1987), and Rogerson (1987).

$a(\mu+\alpha)+B(\alpha)$, with regard to α. For the contracting firm to choose slack $\alpha(\mu)$ when the cost environment is μ, it is necessary that:

$$a'[\mu+\alpha(\mu)]+B'[\alpha(\mu)]=0, \tag{8}$$

provided $\alpha(\mu)>0$. Because of equation (4), equation (8) can be rewritten as:

$$b[\mu+\alpha(\mu)]=B'[\alpha(\mu)]. \tag{9}$$

Equation (9) will be used to determine the cost-share parameters in the next section. However, for this equation to become operational, the government first needs to identify the desired slack policy $\alpha(\mu)$.

Lemma 1 confirms the intuition that it is preferable for the government to let the better-informed firm determine the cost-share parameter. With a traditional cost-plus-incentive-fee contract, the firm will choose the same amount of slack in all cost environments so that the marginal value of slack equals the cost-share parameter of the incentive contract. Under a budget-based scheme, the government can additionally offer incentive contracts with higher cost-share parameters. The firm will select a "steeper" contract if it has favorable cost information. In those cases the firm will earn a higher profit, but since the project is conducted more efficiently, both sides can be made better off.

II. Constructing Budget-Based Schemes

From a practitioner's perspective, implementation of a cost-plus-incentive-fee contract requires the choice of three numbers: a cost-share parameter, a target cost level, and a target profit level.[15] In contrast, the budget-based schemes, which effectively consist of a menu of cost-plus-incentive-fee contracts, require an entire schedule of these parameters. This leaves the government with the task of selecting budget-based schemes for alternative procurement projects. Preferably, the selection procedure should not require detailed understanding of the underlying incentive theory.

To state a specific budget-based contract, the government may use the general formula in equation (2) in conjunction with formulas for the functions $a(\bullet)$ and $b(\bullet)$. A simpler alternative may be to express the contract by tabulating the incentive profit that the firm will receive for alternative levels of estimated and actual costs.[16]

The following steps provide a procedure for constructing a suitable budget-based incentive scheme. The government first assesses a number of basic parameters that reflect its beliefs regarding minimum cost and cost-padding opportunities. On the basis of these parameters, the government carries out a sequence of computations whose final output is the desired matrix of incentive profits. This matrix can be supplemented with a set of interpolation rules that compute the incentive profit for values of estimated and actual cost not contained in the matrix.

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[15] GAO (1987) describes how the government determines these parameters.

[16] This approach has been implemented by IBM in the context of salesforce compensation. According to Gonik (1978), IBM offered a menu of compensation plans via a matrix, whose entries show a manager's sales commission for alternative combinations of forecasted and actual sales. Also, Gates (1988) describes a contracting situation where an "agent" was offered a menu consisting of two alternative incentive schemes.

Step 1: Assessing Basic Parameters

First, the government has to assess the interval $[\underline{\mu},\bar{\mu}]$; that is, the range of possible cost expectations that the firm might hold if it conducted the project with maximum efficiency. For most projects, the government will formulate a reservation or ceiling value representing the highest cost estimate (unbiased) for which it would be willing to undertake the project. When this ceiling value is denoted by $\bar{E}$, the range of admissible cost estimates becomes the interval $[\underline{\mu},\bar{E}]$. In the subsequent analysis, $\bar{E}$ is considered an exogenously given parameter.[17]

To construct the matrix of incentive profits, it will be useful to divide the interval $[\underline{\mu},\bar{E}]$ into k subintervals. The interpretation is that the firm can choose one of the $(k+1)$ estimates E_i, where $E_i<E_{i+1}$ for $1\leq i\leq k$. It will be convenient to let $\underline{\mu}=E_0$ and $\bar{E}=E_k$. An obvious trade-off is associated with the number k. The larger the value of k, the closer the discrete incentive scheme will approximate the optimal continuum solution.[18] On the other hand, too large a value of k would make the resulting matrix of incentive profits impractical. Representatives of the GDOD felt that k should be between five and ten (in the application described in section III, k is equal to 7).

Step 2: Determining the Cost-Share Parameters b(E)

As argued in the previous section, the optimal cost-share parameters are given, in principle, by equation (9) with the optimal slack policy $\alpha(\mu)$ determined by the two characteristics of the underlying agency problem: the government's prior distribution $N(\mu)$ and the benefit function $B(\alpha)$.[19] To characterize the optimal function $b(\bullet)$, specific functional forms for $N(\mu)$ and $B(\alpha)$ are considered. The resulting characterizations are useful only to the extent that the functional forms provide a "reasonable" approximation of the actual functions $N(\mu)$ and $B(\alpha)$ as assessed by the government.

In considering the range of desired cost-share parameters, it is possible to provide upper and lower bounds for the cost-share parameters in terms of the firm's benefit function, $B(\alpha)$. Recall from section I that $B(\bullet)$ is assumed to be concave with $0\leq B'(\alpha)\leq 1$. Denote $v_1=B'(0)$. A special case of interest occurs if the function $B(\bullet)$ is such that from a certain point on the marginal value of slack remains constant (e.g., the firm receives the equivalent of 20 cents for every additional dollar of slack). Formally:

$$B'(\alpha)=v_2 \qquad \text{for } \alpha\geq\alpha^*. \tag{10}$$

Observation 1: If equation (10) holds, the optimal cost-share parameters satisfy:

$$v_2\leq b(E)\leq v_1. \tag{11}$$

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[17] The ceiling $\bar{E}$ can be derived as follows. Suppose the government attaches a gross benefit of R dollars to the project. For R sufficiently large, the project will be conducted for any cost environment μ. Furthermore, the lemma in section I states that a budget-based scheme is optimal. It can be shown that, as R decreases, a "truncated" budget-based scheme is optimal, such that the government conducts the project only if $E\leq\bar{E}$, where $\bar{E}$ is a decreasing function of R.

[18] In the context of a monopolist offering a menu of services, Wilson (1988) examines the loss associated with offering just k different services rather than a continuum. Wilson shows that the relative loss associated with a finite menu goes rapidly to zero as k get large. Specifically, the difference between the continuum and the finite solution converges to zero at a rate of at least $1/k^2$.

[19] The exact formula for the optimal $\alpha(\mu)$ in terms of $N(\mu)$ and $B(\alpha)$ is given by equation (1A) in the appendix.

As shown in the appendix, the upper bound v_1 is indeed the optimal sharing parameter corresponding to the lowest estimate. As a consequence, the firm will conduct the project with maximum efficiency (i.e., $\alpha=0$). Note that if $v_1=1$, the incentive contract assigns a fixed-price contract to the lowest cost estimate. The result $b(E)\geq v_2$ reflects that the government wants to contain the amount of slack at α^*.[20]

As argued above, incentive compatibility requires the function $b(\bullet)$ to be monotone decreasing. Characterizing the curvature of $b(\bullet)$ turns out to be difficult in general, but a tractable special case results when the benefit function $B(\bullet)$ is of the following linear-quadratic form:

$$B(\alpha)=\begin{cases} s_1\bullet\alpha-\dfrac{s_2}{2}\bullet\alpha^2 & \text{if } \alpha\leq\alpha^* \text{ and} \\ (s_1-s_2\bullet\alpha^*)\bullet\alpha+\dfrac{s_2}{2}\bullet\alpha^{*2} & \text{if } \alpha>\alpha^*. \end{cases} \tag{12}$$

The three parameters (s_1,s_2,α^*) are to be selected so that $s_1-s_2\bullet\alpha^*$ is positive, which ensures that $B(\bullet)$ is increasing and concave. Note that, by definition, $s_1-s_2\bullet\alpha^*=v_2$. As shown in the appendix, the desired slack policy $\alpha(\mu)$ will be increasing at the same rate as the inverse hazard rate, $h(\mu)$, if the benefit function is of the linear-quadratic form in equation (12). Hence, $\alpha(\mu)$ will be convex (concave) whenever $h(\mu)$ is convex (concave).

To tie this characterization to the curvature of $b(\bullet)$, note that the right-hand side of equation (9) is linearly decreasing in α for linear-quadratic benefit functions. Thus, one would expect $b(\bullet)$ to be decreasing at a decreasing rate (i.e., $b(\bullet)$ to be convex) whenever $\alpha(\mu)$ increases at a decreasing rate. To state the formal result, it is useful to introduce the following terminology: the relevant domain of the function $b(\bullet)$ is the interval (E_*,E^*), where E_* is defined to be the largest value of E such that $b(E)=v_1$ for all $E\leq E_*$, and E^* is the smallest value of E such that $b(E)=v_2$ for $E\geq E^*$. Hence the relevant domain is the range of cost estimates where the function $b(\bullet)$ assumes values intermediate between v_1 and v_2 (of course, it is possible that $E_*=\underline{\mu}$, and $E^*=\bar{E}$).

Observation 2: If equations (10) and (12) hold, the function of optimal cost-share parameters is convex (concave) on the relevant domain, whenever the function $h(\mu)$ is concave (convex).[21]

An immediate consequence of this result is that when the government's prior distribution is uniform, the cost-share parameters decrease linearly on the relevant domain. The appendix contains a proof of Observation 2 and an explicit computation of the optimal sharing parameters for the following family of probability densities:

$$n(\mu)=\begin{cases} c\bullet(\mu-\underline{\mu})^r & \text{if } \mu\leq m \text{ and} \\ c\bullet(\bar{\mu}-\mu)^r & \text{if } \mu\geq m. \end{cases} \tag{13}$$

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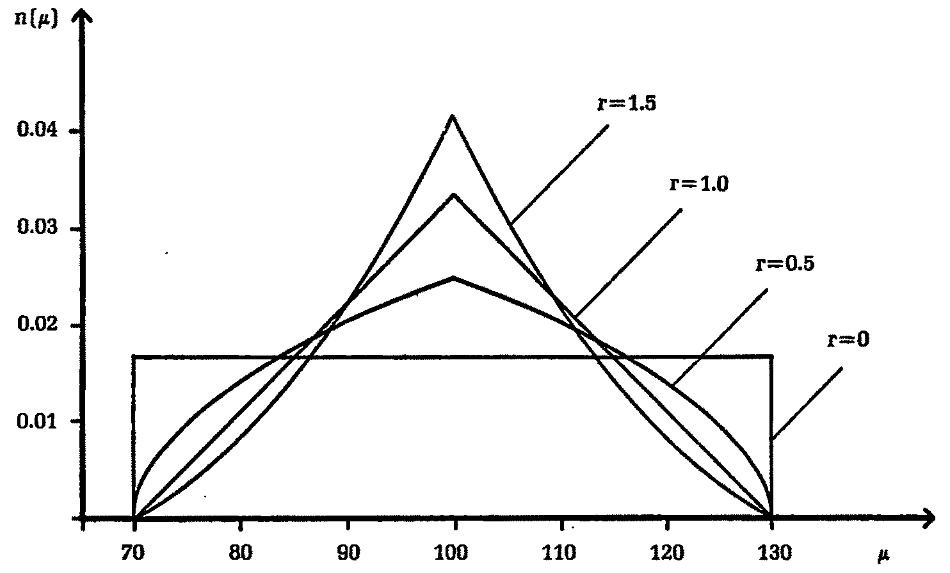
[20] An implicit assumption of the underlying agency model is that the presence of the government's auditors does not create "effective" upper bounds on the amount of slack that the firm could choose.

[21] It is sufficient that $h(\mu)$ be concave (convex) for those μ corresponding to the relevant domain, i.e., on the interval $[E_*,\mu^*]$, where $\mu^*+\alpha^*=E^*$.

Figure 1
Illustration of the Density Given by Equation (13)



Here, $r \geq 0$ is a parameter to be chosen, m is the midpoint between $\underline{\mu}$ and $\bar{\mu}$, i.e.,

$$m = \frac{1}{2}(\underline{\mu} + \bar{\mu}),$$

and c is a constant ensuring that $n(\bullet)$ is a density.[22] If $r=0$, the distribution is uniform; for $r>0$, the distribution is single peaked and symmetric around the mean m. The parameter value r indicates the variance of the random variable μ. The higher the value of r, the lower the variance since more probability weight is centered around the mean m. Figure 1 illustrates the shape of this distribution for four alternative values of r ranging between zero and 1.5.

For the family of probability distributions in equation (13), it turns out that the inverse hazard rate, $h(\mu)$ is linear on the interval $[\underline{\mu}, m]$ and strictly convex thereafter. In light of Observation 2, the function $b(\bullet)$ is therefore concave on the relevant domain. The explicit formula for $b(\bullet)$ in terms of the six parameter values $(\underline{E}, \bar{E}, s_1, s_2, \alpha^*, r)$ is given in the appendix.

In summary, the above analysis provides a partial characterization of the desired function $b(\bullet)$ with regard to its range and curvature. An explicit computation of the optimal cost-share parameters is possible for the specific functional forms given in

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[22] It is readily verified that $N(\bar{\mu})=1$ if,

$$c = \frac{r+1}{2}(m - \underline{\mu})^{-(r+1)}.$$

equations (12) and (13). It should be noted, though, that these functional forms may not provide a "sufficiently good" approximation of the functions $N(\bullet)$ and $B(\bullet)$ as assessed by the government for a particular procurement project. For example, the government's prior distribution may not be symmetric around the mean, and therefore the functional form in equation (13) may not provide an appropriate representation. In those cases, a contract designer may seek to access the underlying agency model directly. For given functions $N(\bullet)$ and $B(\bullet)$, the optimal slack policy $\alpha(\mu)$ an be derived according to equation (1A) in the appendix. Thereafter, the optimal cost-share parameters $b(E)$ can, in principle, be determined according to equation (9). Most likely, these solutions would be obtained in practice through numerical analysis.

To derive the matrix of incentive profits, it is, of course, sufficient to select only the $k+1$ cost-share parameters $b(E_i)$, $0 \leq i \leq k$. It will be convenient in the subsequent steps to proceed as if the desired function $b(\bullet)$ is linear on each interval (E_i, E_{i+1}). One then obtains a piecewise linear approximation of the "optimal" $b(\bullet)$. The loss associated with this approximation diminishes as k gets larger.

Step 3: Computing the Target Profits a(E)

The discussion in section I shows that, up to a constant of integration the target profits $a(E)$ of any incentive compatible budget-based scheme are uniquely determined by the cost-share parameters $b(E)$. Hence, the only discretion left to the contract designer is a boundary value, denoted by c, that gives the target profit for the highest cost estimate $E_k = \bar{E}$. Thus,

$$a(\bar{E}) = c. \tag{14}$$

If the threshold value is not to distort the reporting incentives, the constant c must satisfy the requirement that the firm is indifferent between accepting and rejecting the contract when its estimate of expected project cost equals $\bar{E}$. As will become clear in the next section, however, the choice of c is likely to be affected by other constraints in practice.

Observation 3: Given a function of cost-share parameters $b(\bullet)$ which is linear on each interval (E_i, E_{i+1}) the target profits can be computed recursively by equation (14) and:

$$a(E_i) = a(E_{i+1}) + \frac{1}{2}[b(E_i) + b(E_{i+1})] \bullet (E_{i+1} - E_i), \quad \text{for } 1 \leq i \leq k-1. \tag{15}$$

To verify equation (15), recall that equation (4) implies:

$$a(E_i) = a(E_{i+1}) + \int_{E_i}^{E_{i+1}} b(E)dE, \tag{16}$$

for arbitrary values of E_i and E_{i+1}. Since the cost-share parameter function $b(\bullet)$ is linear on each segment $(E_i E_{i+1})$, an immediate geometric argument shows that the integral of $b(\bullet)$ between E_i and E_{i+1} is given by

$$\frac{1}{2}[b(E_{i+1}) + b(E_i)] \bullet (E_{i+1} - E_i).$$

Hence, equation (15) holds.

To complete the construction of the matrix of incentive profits, one needs to choose p different actual cost figures $\{x_1,\ldots,x_p\}$. Since the firm has an incentive to provide an unbiased report of the expected cost in the first stage, it seems natural to choose the values x_i from the range of possible cost estimates, that is, the interval $[\underline{\mu},\bar{E}]$. Given values for $b(E_i)$ and $a(E_i)$, the matrix of incentive profits can thereafter be calculated according to equation (2) for all $k \cdot p$ pairs of estimated and actual cost.

Step 4: Interpolation Rules

Representatives of the GDOD suggested that the matrix of incentive profits be appended by interpolation rules that determine the incentive profit for combinations of x and E not contained in the matrix. With regard to actual cost x, the interpolation rules are obvious since the budget-based schemes are linear in actual cost. Therefore, if $x=\beta \cdot x_j+(1-\beta) \cdot x_{j+1}$, the incentive profit would be interpolated linearly:

$$H(E_i,x)=\beta \cdot H(E_i,x_j)+(1-\beta) \cdot H(E_i,x_{j+1}). \tag{17}$$

Similarly, the incentive profit would be extrapolated linearly for actual cost levels x outside the interval $[x_1,x_p]$.

With regard to the estimates E, the interpolation rules have to create a new row in the matrix for any estimate E with $E_i<E<E_{i+1}$. This requires calculation of $a(E)$ and $b(E)$ in terms of the neighboring values, E_i and E_{i-1}. Since the function $b(\cdot)$ is taken to be linear on the interval $[E_i,E_{i+1}]$, the natural interpolation rule is:

$$b(E)=b(E_{i+1})+\frac{b(E_i)-b(E_{i+1})}{E_{i+1}-E_i}(E_{i+1}-E), \tag{18}$$

and

$$a(E)=a(E_{i+1})+\frac{1}{2}[b(E)+b(E_{i+1})] \cdot (E_{i+1}-E). \tag{19}$$

These equations can be combined with the basic formula in equation (2) to generate the new row corresponding to any estimate E with $E_i<E<E_{i+1}$. Note that if the functional $b(\cdot)$ is linear on each interval (E_i,E_{i+1}), then the expressions in equations (18) and (19) generate the values that would have resulted had the estimate E been one of the points of the partition. Thus, if the matrix of incentive profits is supplemented by the interpolation rules in equations (17) through (19), it will lead to the same behavior and performance as a continuum scheme whose function $b(\cdot)$ is piecewise linear.

III. Application of the Budget-Based Schemes in Germany

Profit Policy

When the budget-based schemes were presented to representatives of the GDOD, the first concern was to ensure that these schemes were compatible with existing procurement rules. The German procurement laws set a framework for the calculation of contractors' profits under cost-based contracts.[23] The contractor's base profit is typically proportional to the value of the project as measured by actual costs verified ex

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[23] The general rules are stated in the so-called "Leitsatze zur Preisverodnung," abbreviated as LSP.

post by government auditors.[24] The markup factor currently amounts to about 5 percent, though this varies slightly by the extent to which project components are supplied by subcontractors.[25]

In addition to base profit, contractors may be paid an incentive or performance profit. Although there is no general formula for the calculation of such profits, the law stipulates that incentive profits may be granted only to reward "exceptional contractor effort with regard to technical, organizational or economic performance."[26] The question then becomes whether the incentive profits arising from the use of a budget-based scheme in fact reward exceptional contractor effort. For instance, if the firm submits a relatively low estimate E and actually achieves that standard (i.e., $x=E$), it will be entitled to an incentive profit of $\alpha(E)$, even though, relative to the self-selected standard E, there was no "exceptional contractor effort." It was agreed that the budget-based schemes are nonetheless compatible with the German procurement laws. By submitting a low estimate, the firm subjects itself to a larger risk of negative incentive profits and this exposure warrants a premium, even if the firm merely achieves its self-selected standard.[27] To embed the budget-based incentive schemes into the current procurement framework, it was suggested that the incentive profit be viewed as a payment over and above the firm's base profit. Accordingly, the price paid by the government can be expressed as:

$$\text{Price}=\text{Actual Cost}+\text{Base Profit}+\text{Incentive Profit.} \qquad (20)$$

Representatives of the GDOD felt that the expected incentive profit should be positive so long as expected cost is below the threshold $\bar{E}$. The budget-based schemes will satisfy this requirement provided that $\alpha(\bar{E})=0$ (and hence $\alpha[E]>0$ for $E<\bar{E}$).[28] One consequence of this specification is that the firm will never be worse off in terms of expected profit than under a cost-plus-fixed-fee contract (or proportional-fee contact). It was emphasized that this "individual rationality" property is essential for widespread implementation of the budget-based schemes. Because of political pressure the DOD would find it difficult to implement the schemes if defense contractors perceived them as an attempt to "squeeze" contractor profits. In contrast, the budget-based schemes become more palatable if introduced as a mechanism for improving efficiency and making both sides better off in the process.

Many cost-based government contracts are subject to price ceilings.[29] With a cost-plus-fixed-fee contract, the imposition of a price ceiling is effectively the only instrument the government has to contain cost overruns. Though the above model analysis suggests that there is no need for such ceilings given proper incentive provisions, representatives of the GDOD decided to maintain price ceilings in conjunction with the budget-based schemes. To ensure that the resulting project price never exceeds the price ceiling, say $\bar{P}$, actual cost can be reimbursed only up to some cost ceiling K. If the firm issues the highest possible estimate $E=\bar{E}$, the value of K is obtained by solving the linear equation:

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[24] As mentioned in the introduction, such cost-plus-proportional-fee contracts are not admissible in the United States. Currently, there are various efforts under way to change the formula for the calculation of base profits in Germany.

[25] As discussed by Osband (1988) and Rogerson (1988) the calculation of base profit in the United States is concerned with two major considerations: that the contracting firm earn an "adequate" return on capital and, in addition, be reimbursed for certain unrecognized costs, e.g., interest expenses.

[26] See LSP, No. 50–52. The law does not stipulate, though, that incentive profits have to be positive.

[27] The suggestion to interpret $\alpha(E)$ as a reward for the firm's willingness to reveal its favorable cost information was rejected by one procurement officer with the argument: "By law, they are required to provide us that information anyhow, so we can't pay a premium for that!!"

[28] The boundary condition $\alpha(\bar{E})=0$ may bias the firm's cost estimate if $E>\bar{E}$. For firms to report truthfully expected cost in excess of $\bar{E}$, it may be necessary to set $\alpha(\bar{E})<0$.

[29] Cost-plus-incentive-fee contracts that are subject to a price ceiling are usually referred to as fixed-price-incentive contracts (see GAO 1987).

$$\bar{P}=K+BP(K)+a(\bar{E})+b(\bar{E})\cdot(\bar{E}-K), \tag{21}$$

where $BP(x)$ denotes the firm's base profit (as mentioned above, the current rule in Germany is roughly $BP(x)=0.05\cdot x$). For simplicity, it was decided further to set $K=\bar{E}$. Since $a(\bar{E})=0$, equation (21) then reduces to $\bar{P}=K+BP(K)$. For cost estimates below $\bar{E}$, it would be possible to increase the value of the cost ceiling without violating the overall price ceiling.[30] In the application described below, however, the government opted for one cost ceiling only.

The introduction of cost ceilings may distort the incentives created by the budget-based schemes. Since the contracting firm bears 100 percent of all costs in excess of the ceiling K, the compensation scheme is piecewise linear with a kink at K. Recall that, for the model described in section I, the firm has partial control over the expected project cost $z=\mu+\alpha(\mu)$, yet actual cost x is a random variable with some probability distribution $F(x|z)$. For concreteness, suppose that $x=z+\epsilon$, where ϵ denotes a random variable with mean zero and support $[\underline{\epsilon},\bar{\epsilon}]$. If $z+\epsilon>K$, and therefore actual cost x exceeds the ceiling K with positive probability, the firm's incentives will be affected in two ways. First, there will be a stronger incentive to reduce the amount of slack $\alpha(\mu)$. However, strengthening the firm's performance incentives will not be in the government's interest if the original budget-based scheme already provided optimal performance incentives.

Second, the presence of a cost ceiling affects the firm's reporting incentives. It is no longer in the firm's interest to provide an unbiased cost estimate (i.e., to report $E=z$). Instead, the firm will be better off by underestimating the expected cost (i.e., by reporting $E<z$). To see this, note that without cost ceilings the firm would not want to issue an unrealistically low cost estimate because cost overruns would be penalized at a higher rate. In the presence of cost ceilings, however, cost overruns in excess of K are penalized at the same rate (100 percent) irrespective of the cost estimate. Therefore, the firm will have an incentive to bias its cost estimate downward. The resulting distortions tend to be smaller as the noise term ϵ centers more of its probability weight around the mean zero. In general, though, there is no evidence that the budget-based schemes will remain optimal incentive mechanisms in the presence of price and cost ceilings.

Implementation for Pilot Projects

First applications of the budget-based schemes were undertaken in the fall of 1989 and spring of 1990 in the context of two development contracts (with two separate suppliers). Procurement officers of the GDOD indicated that the use of a budget-based scheme was decided fairly late during the contract negotiations in both cases. Orig-

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[30] Let $K^*(E)$ denote the cost ceiling corresponding to the estimate E. The value of $K^*(E)$ solves the linear equation: $\bar{P}=K^*(E)+BP[K^*(E)]+a(E)+b(E)\cdot[E-K^*(E)]$. Since $b(\cdot)$ is decreasing and $a'(E)=-b(E)$, it follows directly that $K^*(E)$ is decreasing in E. Furthermore, $K^*(\bar{E})=\bar{E}$.

Table 1
Matrix of Incentive Profits for One GDOD Project

		Actual Cost (as a percentage of project cost ceiling)							*Cost-Share Parameter (%)*
		70	75	80	85	90	95	100	
Estimated Cost (as a percentage of project cost ceiling)	70	10.6	8.0	5.6	3.1	0.6	−1.9	−4.4	50
	75	10.3	8.1	5.8	3.6	1.3	−0.9	−3.2	45
	80	10.0	7.9	5.9	3.9	1.9	−0.2	−2.3	42
	85	9.6	7.8	5.8	4.1	2.3	0.4	−1.5	37
	90	9.0	7.3	5.7	4.0	2.5	0.8	−0.8	32
	95	8.1	6.7	5.3	3.9	2.4	1.1	−0.3	26
	100	4.4	3.6	2.9	2.2	1.4	0.8	0.0	15

inally, the government intended to conduct both projects as cost-plus-proportional-fee contracts (with a markup of approximately 5 percent) subject to a price ceiling. In fact, the government negotiatiors presented the particular budget-based schemes only after the price ceilings had been negotiated. Table 1 shows the matrix of incentive profits for one of the projects.

Table 1 shows that if the contracting firm were to issue the estimate $E=K$, its incentive profit would be zero if actual costs were to be greater than or equal to K. For actual cost x less than K the firm would receive 15 percent of the budget variance $(K-x)$ as its incentive profit. By providing the estimate $E=K$, the contracting firm would always be better off than under the original cost-plus-proportional-fee contract. It would receive at least as high profits irrespective of actual cost.

The contract designers apparently felt that in the best of circumstances the contracting firm might issue a cost estimate of 70 percent of K. In accordance with the prescriptions in sections I and II, the cost-share parameters decrease monotonically over the interval (70, 100), and range from 0.5 to 0.15. The corresponding target profits $a(E_i)$ are the diagonal entries in the matrix. It can be verified that these numbers satisfy the recursive equations in (15) (Ob. 3), with the boundary condition given by $a(100)=0$ (the matrix contains rounding errors due to the fact that the numbers have been computed only to the first decimal point). Under this scheme, the firm's total profit will always be positive. Even when the incentive profit results in a large penalty ($E=70$ percent of K and $x=K$), the firm still earns a profit of $(0.05-0.044)K=0.006K$.

The procurement officers who designed the budget-based scheme in table 1 did not reveal how the cost-share parameters $b(E)$ were actually determined. In particular, it was not made public to what extent the designers of the scheme formally assessed a prior distribution $N(\mu)$ and a benefit function $B(\alpha)$. It should be noted, though, that the cost-share parameters chosen are consistent with the model and the constructive procedure described above. In particular, one can construct functions $B(\alpha)$ and $N(\mu)$ such that the resulting optimal cost-share parameters coincide with the ones in table 1.

In response to the budget-based scheme shown in table 1, the contracting firm submitted a cost estimate of 85 (i.e., $E=85\% \bullet K$). As a consequence, it selected a cost-share parameter of $b=0.37$, and the following total profit equation:

$$\text{Profit}\,(x)=0.05 \bullet x+0.041 \bullet K+0.37(0.85 \bullet K-x) \qquad (22)$$

for $x \leq K$. In case $x > K$, the firm's profit is "frozen" at K; that is, it is given by equation (22) evaluated at $x = K$. The actual cost figure will be known sometime in 1992 or 1993 upon completion of the project.[31] It would then be interesting to find out in some detail how this incentive scheme affected the conduct of the project.

In general, one may ask whether the government should be confident *ex ante* that the above incentive scheme will perform better than the previous cost-plus proportional-fee contract. Leaving aside the theoretical predictions developed in section I, one could argue that even without the above incentive provision, the firm's cost might remain below the ceiling K. If so, the budget-based scheme would result only in additional profits for the firm. However, such an argument would overlook the empirical finding that in the past the actual price paid by the German government was within 5 percent of the price ceiling for more than 90 percent of all cost-plus-proportional-fee contracts.

IV. Concluding Remarks

Although this article has focused on procurement contracting, there are some indications that budget-based schemes might also be useful in the context of public utility regulation. As in procurement contracting, a major issue in utility regulation is that the firm has better information regarding production costs and that many of its actions are unobservable and subject to moral hazard. The predominant method for regulating public utilities in the United States (and many other countries) is rate-of-return regulation. As observed by numerous practitioners and academic researchers, a major drawback of rate-of-return regulation is that the utility has little incentive to reduce or contain its operating costs. It is therefore not surprising that regulators have experimented with profit-sharing arrangements similar in spirit to the cost-plus-incentive-fee contracts discussed in section I. Brown et al. (1989) discuss the types of incentive plans that have been adopted by state regulators.[32]

In testimony before the Federal Energy Regulatory Commission, Brown (1990) advocates the use of a budget-based scheme for adjusting the rate base of a power plant in Michigan.[33] The perceived benefits of such an incentive scheme include unbiased estimation of future capital spending by the utility as well as more reliable estimates of the resulting electricity prices. Perhaps more important, the utility would have an incentive to reduce its capital spending, depending on the magnitude of the cost-share parameter chosen. Of course, this incentive would even be stronger under a price cap arrangement, yet, as discussed before, fixed-price contracts are likely to result in larger informational rents that would have to be paid for by consumers.

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[31] Actual results for the other pilot project will probably also be known sometime in 1992 or 1993.

[32] A prominent example of profit sharing is the so-called "sliding scale" of rates adopted for the Potomac Electric Power Company. Bussing (1936) reports that in 1925 the Public Utilities Commission of the District of Columbia granted the utility a basic 7.5 percent rate of return on its rate base. If in any particular year actual profit exceeded the target 7.5 percent return, half of the excess profit was to be absorbed the next year. Accordingly, if all other variables remained constant, the utility's output prices were to be lowered the next year, so that operating profit would be reduced by half of the previous year's excess profit.

[33] The rate base comprises those long-term assets on which the firm is allowed to earn its rate of return.

Appendix

It is shown in Kirby et al. (1991) that the optimal $\alpha(\mu)$ is given by pointwise minimization of the government's expected total cost (project cost plus profit paid to the firm):

$$(\mu+\alpha)-B(\alpha)+\frac{N(\mu)}{n(\mu)}\bullet B'(\alpha), \tag{1A}$$

where $\alpha\geq 0$. Under the assumptions of the lemma, the resulting function $\alpha(\mu)$ will be (weakly) increasing.

To verify Observation 1, we note that if:

$$\frac{N(\underline{\mu})}{n(\underline{\mu})}=0,$$

then equation (1A) is minimized at $\alpha=0$ for $\mu=\underline{\mu}$. This, in turn, implies $b(\underline{\mu})=b[\underline{E}]=B'(0)$.[34] If,

$$\frac{N(\underline{\mu})}{n(\underline{\mu})}>0,$$

then $\alpha(\underline{\mu})\geq 0$, which implies that $b(\underline{E})\geq B'(0)$. To see that $b(E)\geq v_2$ (where $v_2=B[\alpha^*]$), let μ^* be the lowest value of μ such that $\alpha(\mu)=\alpha^*$.[35] Since $B'(\alpha)=v_2$ for $\alpha\geq\alpha^*$, the expression in equation (1A) is minimized by $\alpha(\mu)=\alpha^*$ for all $\mu\geq\mu^*$. Hence $b(E)=v_2$ for all $E\geq\mu^*+\alpha^*$.

To prove Observation 2, we substitute the linear-quadratic function $B(\alpha)$ (as given in eq. [12]) into equation (1A) and solve for $\alpha(\mu)$:

$$\alpha(\mu)=\begin{cases} 0 & \text{for } \mu\leq\mu_*, \\ \dfrac{s_1-1}{s_2}+\dfrac{N(\mu)}{n(\mu)} & \text{for } \mu_*\leq\mu\leq\mu^*, \text{ and} \\ \alpha^* & \text{for } \mu^*\leq\mu. \end{cases} \tag{2A}$$

The values μ_* and μ^* are determined by the equations:

$$\frac{1-s_1}{s_2}=\frac{N(\mu_*)}{n(\mu_*)} \text{ and } \frac{s_1-1}{s_2}+\frac{N(\mu^*)}{n(\mu^*)}=\alpha^*.$$

Recalling equation (9), we obtain:

$$b[\mu+\alpha(\mu)]=s_1-s_2\bullet\alpha(\mu), \tag{3A}$$

if $\mu\leq\mu^*$, and $b(\mu+\alpha^*)=s_1-s_2\bullet\alpha^*$ for $\mu>\mu^*$. It will be convenient to rewrite equation (3A) as:

$$b(z)=s_1-s_2\bullet[z-\gamma(z)], \tag{4A}$$

where $\mu^*+\alpha^*\geq z\geq\mu_*+\alpha(\mu_*)$, and $\gamma(z)$ is the inverse of the map $\phi(\mu)$ defined by $\phi(\mu)\equiv\mu+\alpha(\mu)$. Differentiation of equation (4A) yields:

$$b'(z)=-s_2\bullet[1-\gamma'(z)].$$

Therefore, $b'(z)$ will be increasing (equivalently $b[z]$ will be convex) if $\gamma(z)$ is convex. This will be the case if $\phi(\mu)$ is concave, or, in light of equation (2A), if the function $h(\mu)$ is concave. This completes the proof of Observation 2.

The following is an explicit characterization of the optimal cost-share parameters for the special case where the benefit function $B(\alpha)$ and the prior distribution $N(\mu)$ satisfy equations (12) and (13), respectively.

Claim: Given equations (13) and (14), the optimal cost-share parameters $b(E)$ are given by:

$$b(E)=\begin{cases} s_1 & \text{for } E_0\leq E\leq z, \\ s_1-s_2\bullet\left[\dfrac{1}{r+2}(E-z_1)\right] & \text{for } z_1\leq E\leq z_2, \\ s_1-s_2\bullet\tau(E) & \text{for } z_2\leq E\leq z_3, \text{ and} \\ s_1-s_2\bullet\alpha^* & \text{for } z_3\leq E\leq\bar{E}, \end{cases} \tag{5A}$$

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[34] Obviously, the government cannot benefit by setting $b>B'(0)$.

[35] Depending on the value of $\bar{E}$, it may be that $\alpha(\mu)<\alpha^*$ for all μ satisfying $\mu+\alpha(\mu)\leq\bar{E}$. If so, $b(E)>v_2$ for all admissible cost estimates.

where:

$$z_1=\underline{\mu}+(r+1)\cdot\frac{1-s_1}{s_2},$$

$$z_2=m+\frac{1}{r+1}(m-z_1),$$

$z_3=y+\alpha^*$, with y solving the equation,

$$\alpha^*=\frac{1}{r+1}\left[2\cdot\frac{(\bar{\mu}-m)^{r+1}}{(\bar{\mu}-y)^r}-(\bar{\mu}-y)-(z_1-\underline{\mu})\right].$$

The function $\tau(E)$ is increasing and convex with

$$\tau(z_3)=\alpha^*, \tau(z_2)=\frac{1}{r+2}(z_2-z_1),$$

$$\tau'(E)\geq\frac{1}{r+2} \qquad \text{for all } E\in(z_2,z_3).$$

Proof: For the probability distributions in equation (13) we find that

$$\frac{N(\mu)}{n(\mu)}=\begin{cases}\frac{1}{r+1}(\mu-\underline{\mu}) & \text{if } \mu\leq m \text{ and}\\ \frac{1}{r+1}\left[2\cdot\frac{(m-\underline{\mu})^{r+1}}{(\bar{\mu}-\mu)^r}-(\bar{\mu}-\mu)\right] & \text{if } \mu\geq m.\end{cases} \tag{6A}$$

Combining equations (2A) and (6A), we obtain:

$$\alpha(\mu)=\begin{cases}0 & \text{if } \mu\leq\mu_*,\\ \frac{1}{r+1}\ (\mu-\mu_*) & \text{if } \mu_*\leq\mu\leq\mu,\\ \frac{1}{r+1}\left[2\cdot\frac{(m-\underline{\mu})^{r+1}}{(\bar{\mu}-\mu)^r}-(\bar{\mu}-\mu)-(\mu_*-\underline{\mu})\right] & \text{if } m\leq\mu\leq\mu^*, \text{ and}\\ \alpha^* & \text{if } \mu\geq\mu^*.\end{cases}$$

Substitution in the above equations for μ_* and μ^* implies that:

$$\mu_*=\underline{\mu}+(r+1)\cdot\frac{1-s_1}{s_2},$$

and μ^* is given as the solution to the equation:

$$\alpha^*=\frac{1}{r+1}\left[2\cdot\frac{(m-\underline{\mu})^{r+1}}{(\bar{\mu}-\mu^*)^r}-(\bar{\mu}-\mu^*)-(\mu_*-\underline{\mu})\right].$$

Correspondingly, we obtain the cost estimates $z_i=\mu_i+\alpha(\mu_i)$, with $z_2=m+\alpha(m)$, as given in the statement of the lemma.

The lowest cost share parameter inducing $\alpha(\mu)=0$ for $\mu_*>\mu>\underline{\mu}$ is $B'(0)=s_1$. Thus, $b(E)=s_1$ for $E_0=\underline{\mu}\leq E\leq\mu_*=z_1$. For $\mu^*>\mu>\mu_2$ the firm's choice of slack is interior, satisfying

$$b[\mu+\alpha(\mu)]=s_1-s_2\cdot\alpha(\mu),$$

or, equivalently,

$$b(E)=s_1-s_2[E-\phi^{-1}(E)],$$

with $\mu+\alpha(\mu)\equiv\phi(\mu)=E$. Since $\phi(m)=z_2$, it follows that,

$$\phi(\mu)=\mu+\frac{1}{r+1}(\mu-\mu_*),$$

for $\mu_* < \mu < m$, and thus,

$$b(E) = s_1 - s_2\left[\frac{1}{r+2} \bullet (E - z_1)\right]$$

for $z_2 \geq E \geq z_1$. Finally, $z_3 = \mu^* + \alpha(\mu^*) = \mu^* + \alpha^*$. It follows immediately that $\alpha(\mu) = \alpha^*$, for $\mu \geq \mu^*$ provided $b(E) = s_1 - s_2 \bullet \alpha^*$ for $E > z_3$.

The claims regarding the function $\tau(\bullet)$ remain to be proved. Convexity of the function $\tau(\bullet)$ follows from Observation 2. Continuity of the function $\alpha(\bullet)$ combined with the fact that $\tau(E) = E - \phi^{-1}(E)$ implies that,

$$\tau(z_2) = \frac{1}{r+2}(z_2 - z_1)$$

and $\tau(z_3) = \alpha^*$. Differentiation of $\tau(\bullet)$ gives,

$$\tau'(E) = 1 - \frac{1}{\phi'[\phi^{-1}(E)]},$$

or, alternatively,

$$\tau'[\phi(\mu)] = 1 - \frac{1}{1 + \alpha'(\mu)} = \frac{\alpha'(\mu)}{\alpha'(\mu) + 1}. \tag{7A}$$

Thus, $\tau(\bullet)$ is monotone increasing. Differentiating $\alpha(\mu)$, as given by (*ii*) on the interval (m, μ^*) yields:

$$\alpha'(\mu) = \frac{1}{r+1}\left[2r \bullet \left(\frac{\bar{\mu} - m}{\bar{\mu} - \mu}\right)^{r+1} + 1\right].$$

Therefore,

$$\alpha'(\mu) \geq \frac{1}{r+1},$$

and:

$$\frac{\alpha'(\mu)}{1 + \alpha'(\mu)} \geq \frac{1}{r+2},$$

proving that,

$$\tau'(E) \geq \frac{1}{r+2},$$

for $z_3 > E > z_2$.

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A Perspective on Accounting for Defense Contracts

Joel S. Demski
Yale University
Robert P. Magee
Northwestern University

THE articles by Reichelstein (1992), Rogerson (1992), and Thomas and Tung (1992) offer fascinating and thought-provoking insights into the world of defense contracting. Their common theme is that pricing practices in this industry may lead to serious distortions. Reichelstein focuses on the possibility of an underinformed design and acquisition choice; Rogerson worries about factor choices; and Thomas and Tung emphasize potentially self-serving pension policy dynamics. These three sets of concerns are all driven by a common theme: the use of particular pricing practices in the defense industry.

Our overview begins with a sketch of institutional features that are somewhat exaggerated in the defense industry. We then highlight contributions from the economics literature that provide insights into these institutional details and their implications. With this background, we turn to the substantive question at hand: What opportunities for accounting scholarship are offered by the defense industry? We conclude with some comments on the three articles as these pertain to the theme of opportunities for accounting scholarship.

The Defense Industry

Important features of the defense industry are (1) an unusual product market, (2) heavy use of quickly changing technology, (3) multiproduct firms, and (4) regulation. The product market is unusual on the demand side because it is dominated by a single customer, the federal government. Other customers are present, such as foreign governments, states, municipalities, and private citizens, but the market is clearly dominated by the single, large customer. This customer is also unusual in that it has regulation, taxation, and coercive powers. The customer can be lobbied and cajoled, but it also can be and has been a producer in the industry.

On the supply side, the usual situation is a small number of suppliers offering differentiated products. Subcontracting among supplies is common, and deep into a product's life, the buyer is usually confined to dealing with a single producer. These characteristics of the industry are often modeled by assuming that the buyer (i.e., the

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federal government) designs the contracting instrument and deals with a single supplier. Both Reichelstein (1992) and Rogerson (1992) are quite explicit on this aspect of the relationship.

Second, technology plays a major role in the industry. This is reflected in the fact that many procurements are shrouded in uncertainty. The cost is uncertain, the performance characteristics of the product are often uncertain, the feasibility of the underlying technology may be in question, and the buyer may be unclear about what package of product attributes it most prefers. Information access further exacerbates this uncertainty. Although the producer often has technological insight and a cost-estimating advantage, the buyer's tastes change frequently. Also, quality assessment and post-delivery maintenance invite moral hazard concerns on the part of the buyer. These factors result in considerable uncertainty, information differences, and a steady flow of change orders in the production process. Opportunities for pre- and post-contract opportunism are abundant on both sides of the relationship, though most models use a relatively static formulation that emphasizes opportunistic behavior by the producer. Reichelstein (1992) emphasizes the producer's private information at the contracting stage, along with cost control incentives. Rogerson (1992) emphasizes cost control incentives, as do Thomas and Tung (1992).

Third, the typical producer is a multiproduct firm. Various defense products, at various stages of the product life cycle, are often present. Commercial products are also usually present. The production setting includes complex manufacturing technology, learning, and hybrid organization forms. Many contracting arrangements are implicit, renegotiation is commonplace, and the typical producer has a variety of activities "under contract" at any given time. This diversity and complexity create profound product-cost measurement difficulties, as well as additional possibilities for opportunistic behavior by both buyer and seller. Rogerson (1992) and Thomas and Tung (1992) emphasize a multiproduct supplier as the particular feature of the industry in their work.

Finally, the industry is heavily regulated. The federal government has a great deal to say about the firm's customer lists (e.g., by banning the sale of some products to private citizens) and accounting practices. It also regulates the "arm's length" encounter between itself and the industry. Pricing and sourcing procedures are standardized; an active grievance structure is in place (complete to the point of losing bidders' being able to grieve and sometimes receive compensation from the winning bidder); and, on occasion, industry profits have been regulated. In addition, the long-term relationships between the buyer and producers are administered by a cadre of professional experts, some of whom move between buyer and producer employment.

Some Economic Perspectives

The modern school of industrial organization (see, e.g., Besanko and Sappington 1987; Spulber 1989; Tirole 1988) emphasizes market imperfections and limited information. An important insight from this perspective is the notion that efficiency is conditioned by the allocation of information. The "second-best" solution emphasized in the usual principal-agent setting is a case in point. Another important lesson is that institutions, including firms, surface in response to trading frictions (see, e.g., Holmstrom and Triole 1989; Williamson 1985). This suggests that a key to understanding defense procurement is an understanding of the particular trade frictions and the institutions that have surfaced to deal with (or tolerate) these frictions.

The modern school, though, does not completely capture the defense procurement setting. The dominant buyer is itself a political institution. This suggests that a variety of motives will appear and shape policy and the institutions that foster this policy. We are quite removed from a monolithic, rational, dominant buyer (rational in the sense of admitting well-behaved preferences that can be measured by an appropriate utility function).

Health care seems to be an industry with many features common to the defense industry. The product market is unusual, with important governmental payers like Medicare and Medicaid and many commerical payers such as insurance companies and individuals. Uncertainty and technology change are present. The producers are generally multiproduct firms and may be organized as producer "cooperatives" (in the guise of prepaid plans), and so on. Regulation is omnipresent, down to the level of administered prices, capacity restrictions, and specification of accounting procedures. Peer producers and significant regulatory intervention (e.g., the switch to DRG pricing), however, have afforded opportunities to estimate cost curves, efficiency, regulatory effects, and so on. For examples, see Robinson and Luft (1985), Dranove (1988), Huang and McLaughlin (1989), and Vita (1990).

Public education provides another reference point. The product market is unusual in that public and private producers compete in the presence of uncertainty about quality. The producers are clearly multiproduct firms, though not with the variety of products we see in defense or health. Regulation is also important. For example, the State of Connecticut mandates a minimum per-pupil expenditure for school districts. This is enforced by accounting regulations and reporting requirements. It has also led to litigation over how to allocate the cost of services provided by the municipality (e.g., for maintenance).

Further, the same sorts of problems extend to interunit transfers within organizations. For example, a division that manufactures components may transfer its products to another division at cost while selling to outside customers at a market price. The same opportunistic possibilities to shift overhead, manipulate reported costs, and create slack occur in the interdivision business.

The defense industry provides a laboratory in which to study the effects of contracting, contract administration, and cost system design on decision making. The details differ, but the broader perspective of accounting as an adaptation to its environment is present.

What About Accounting?

With this background, we turn to the central question of accounting scholarship. What can industry-level studies teach us about accounting? (Industry studies can teach us a great deal about a variety of matters. We have chosen to emphasize accounting.)

At the outset, we recognize that accounting conveys information that is formatted or presented with a valuation language. Periodic income, asset tallies, product cost, and revenue are illustrative. If markets are complete and perfectly functioning, every encounter between a reporting entity and its environment can be gauged with a market price. The accounting task of valuation is perfunctory. Market-based accounting is trivial, and we seem to get precisely what we pay for. In such a pristine world, the accounting product would be elegant and useless because it merely recalculates what everyone knows.

Therefore, market imperfections are the centerpiece of the accounting environment. Accounting is interesting (and controversial) only when markets are incomplete. We then face the prospect of recognizing revenue, determining product cost, valuing inventory, and so on without access to solid price guides (e.g., it is no accident the economic theory of cost focuses on the firm's cost curve, not on the cost of a product).

If markets are not so accommodating, what institutional arrangements surface in their place? In broad terms, the answers are (1) complex (including implicit) contracts and (2) organization. Complex pay-for-performance labor contracts arise only in the face of labor market frictions. Otherwise, we would have separation between labor supply and risk sharing. However, we recognize that complete, clairvoyant contracting instruments are themselves a fiction. Unforeseen circumstances arise, and specific contingencies are left to be dealt with when and if they occur. Organization now enters as a governance device, that is, as an institution that resolves these matters. The firm itself emerges as a manager and administrator of transactions, contrary to the popular, more narrow "nexus of contracts" view.

Accounting may be viewed as one of the "local institutions" that help cement this elaborate structure together. The cost-based incentive arrangements in defense procurement illustrate the role of accounting when a complex contract is being administered. Yet that is only part of the story here. A major procurement award will not go forward if the supplier's technical or financial viability are in question, so the firm's accounting procedures may affect the contracting relationship in other ways.

Change orders are inevitable for many defense products. A stylized principal-agent model would view these changes as managerial input (perhaps with other factors of production) responding to the arrival of information in a fashion programmed by the initial contract. The reality of defense contracting is far less structured. It is understood that change orders will arrive, will be negotiated, and will be costed with the extant accounting system. The ability of the accounting system to respond to these changes, in a more or less predictable fashion, is part of the glue that holds the trade arrangement together.

What accounting is asked to do and the pressures it operates under vary with circumstance. This suggests that a thorough understanding of the insitutions in place is essential to understanding the role played by accounting. Conversely, systematically stepping across institutions allows us to see accounting mixed with other "instruments" as a function of the setting.

This, to us, is the challenge for accounting scholarship that is offered by defense procurement. We have a highly unusual institutional arrangement, with the federal government as the dominant player in the product market, and uncertainty inherent in the products' performance and production process. Given this mix of features, what role does accounting play? What pressures are placed on accounting? What substitute and complementary "instruments" are mixed in? The defense industry offers an inviting opportunity to document accounting choices in an unusual environment.

Review of the Studies

In the first study, Rogerson (1992) looks at the effects of contract diversity, cost structure, and costing practice on the producer's incentives to alter factor combinations, even to the extent of engaging in "pure waste." Proposition 2 and, to a lesser extent, the last part of Proposition 1 summarize the argument. Suppose contract diversity is present in the form of a weighted-average cost sensitivity that differs from some product's cost sensitivity. This diversity provides a wedge to arbitrage cost shifting among the products. Next, suppose overhead costs are not strictly proportional to direct labor cost but are allocated to products on the basis of direct labor cost. This combination can lead to an incentive for the producer to use labor "inefficiently."[1]

This incentive depends critically on the diversity of the firm's contracts in terms of their responsiveness of revenue received to product costs reported. A firm with two fixed-price contracts will have no incentive to shift costs from one project to another; neither does a firm with two cost-plus-fixed-fee contracts. But if one contract is fixed-price and the other is cost-plus-fixed-fee, the firm has an incentive to shift costs from the first contract to the second.

The subtle form of this argument identified by Rogerson (1992) relies on the intricacies of product costing. Suppose our firm has an overhead pool that is allocated to products on the basis of direct labor costs. Further suppose that overhead costs vary in strict proportion to direct labor costs. Increasing direct labor cost for one of the products does not now shift relatively more of the overhead pool to the one product. Everything moves in strict proportion. Of course, a lack of strict proportionality or differing independent variables in the overhead cost function changes the situation significantly. Rogerson's Proposition 1 formalizes this argument regarding the overhead pool that does not vary with a marginal change in labor; Proposition 2 allows for such variation.

This shifting may take many forms, from self-serving misclassification to pure waste. The use of direct labor to allocate overhead amounts to a subsidy of direct labor. Rogerson (1992) estimates the marginal subsidy to be between 20 and 44 percent of wasted labor. These estimates are based on Proposition 1, which holds all other factors, including those recorded in the overhead pool, constant. (However, fringe benefits for direct labor have been moved from overhead to the direct labor cost pool on the assumption that they are strictly proportional.)

In this fashion, we are led to conclude that firms in this industry "... purposely choose inefficient production methods." We must temper this conclusion with the reminder that what we mean by efficiency in a full-information setting differs from its meaning in a private information setting (see Holmstrom and Myerson 1983). In addition, we should consider that subsidizing direct labor might be in the buyer's best interest. One could argue, for example, that with contracts more or less written on explicit products, the DOD fosters "overuse" of direct labor because it wants to maintain a large capacity of skilled workers.

As Rogerson (1992) notes, his results suggest a careful exploration of activity-based costing, with its themes of less aggregation and better identification of "cost drivers." It does not follow, however, that less aggregation or a variety of allocation bases will yield better product-cost estimates (see Christensen and Demski 1991; Datar and Gupta 1992). Moreover, Rogerson's results suggest that producers in this industry might have little incentive to implement such innovations. In addition, the DOD may be reluctant to experiment with different costing procedures because of a strict policy of adhering to the cost-accounting system that was in the original agreement, along with a vast stock of administrative interpretations of allowable costing procedures.

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[1] This incentive is not specific to the use of direct labor. It exists whenever the allocation of overhead costs to products does not mirror the cause-and-effect relationships between the products and the overhead costs.

In his analysis, Rogerson (1992) takes the existence of contract diversity as given. Certainly we observe contract diversity in actual contracting relationships, so the descriptive validity of the assumption is not an issue. Rather, we should recognize that the existence of contract diversity may signal that there are benefits from this diversity, and these benefits may outweigh the costs arising from cost shifting and waste. For instance, a firm may produce one item for commercial customers on a fixed-price basis and another item (using the same production facilities) for the government on a cost-plus basis. Under Rogerson's scheme, the firm will want to shift costs to the latter item. But the government could avoid or reduce that shifting by (1) requiring separate facilities for production of its items or (2) contracting for the item on a fixed-price basis. Yet neither of these alternatives may be more attractive to the government.[2]

Thomas and Tung (1992) examine pension funding behavior for "circumstantial evidence" of cost shifting. As in Rogerson's (1992) analysis, the shifting is predicted to occur when there is diversity in the pricing terms for the company's products. For example, a firm will try to shift costs to cost-plus products from those based on fixed-price contracts, and then, in the pension domain, will switch employees between the projects to continue the practice. Thomas and Tung hypothesize that the amount of cost shifting (over- and underfunding of pensions) would first increase and then decrease as a function of the percentage of the firm's business that is government contracting. They do find this behavior reflected in the data. They also find that defense contractors, when compared to a control group, have more pension plans and greater spread in funding levels, discount rates, and actuarial methods across those plans. This is interpreted as circumstantial evidence that these firms use pension funding to increase their revenues from government contracts. (A number of sensitivity tests finds no change in results.)

In broadest terms, Thomas and Tung (1992) examine a variant of the income-smoothing hypothesis. Through time, and across products, the firm seeks an advantageous assignment of revenues and expenses through a series of operating and accounting choices. While Lambert (1984) and Healy (1985), for example, examined this behavior in terms of executive compensation, Thomas and Tung emphasize product market arrangements as the source of the smoothing incentive. They focus on pension funding because of its potential significance and because it has been an object of explicit regulatory concern. Going a bit further afield, but staying in the pension arena, we see related phenomena in government entities (e.g., federal and state budget practices). Conceptually, it also seems that other items, such as maintenance, would be subject to the same forces.

The study itself uses a control sample, matched with the subject firms on the basis of (1) lack of defense contracting or other forms of regulation and (2) size, as measured by total assets. The control firms, however, are not examined on other dimensions. Do they have roughly the same tax status, for example (see Scholes and Wolfson 1992)? Do they have roughly the same organizational form (e.g., use of subsidiaries)? Do they have roughly the same number of lines of business? Are their manufacturing processes of roughly comparable complexity? For example, producing a modern, $100 million aircraft would require more types of employees (and perhaps more types of pension plans) than producing a million $100 expresso machines, even if the two manufacturers had roughly the same asset total. The control sample is used to neutralize all other influences on employee compensation practices, except for the approach to product pricing. Given that these are complex and incompletely understood practices, the use of control firms is essential but calls for considerable documentation.[3]

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[2] The same argument applies in other settings. Examples are NSF and NIH funding of university research and state funding of local public school districts.

Also, the hypothesized concave relationship between SFL and %DOD is argumentative. If a firm has no DOD business, then it would not over- or underfund, other things equal. Further, a firm with 100 percent (cost-based) DOD business would also have no incentive to over- or underfund. But a firm with 50 percent DOD business would have incentive to overfund on 50 percent of the operations and underfund on the other 50 percent. Why would the overfunding be expected to exceed the underfunding? If ERISA and IRS limits were symmetrical around the proper funding amount, and if other forces were held constant, then we might expect no relationship to be observed in the empirical tests. That is, we are looking for a direct effect and an interaction effect. The control firms, in principle, would allow us to explore this question.

One possibility for an additional test would be to track the %DOD for these firms over a longer time period to test the intertemporal cost-shifting hypothesis. Firms that switched out of (or into) defense contracting during a subsequent time period could provide evidence on this issue. This suggestion for a longer perspective also applies to Reichelstein's (1992) study.

In the Forum's third article, Reichelstein allows for a setting in which the supplier has private information about the cost of completing a project and can influence the efficiency with which the contract is completed. Reichelstein develops a model to identify (optimal) contracts that would encourage accurate forecasting and (more) efficient production. Essentially, a menu of contracts is developed so that lower cost estimates are rewarded with higher expected profits but carry greater penalties if actual costs exceed the cost estimate. Reichelstein describes a process by which the parameters might be estimated and recounts how these concepts were streamlined and applied in German DOD contracting.

One observation that should be made is that this approach to contracting does not obviate the benefits from other control techniques (e.g., auditing and profit regulation). Nor should one infer there are no benefits to the government from improving its ability to estimate project costs. For example, the government is better off if it knows that the project will cost between $4 and $5 million instead of $3 to $6 million. The term "optimal contract" should be narrowly interpreted.

A concern about the implementability of this type of system is the sensitivity of the government's payoff to errors in the estimation process (see Dawes 1988). The menu of contracts requires the estimation of a large number of parameters; Reichelstein (1992) describes an estimation process that (1) requires a considerable list of assumptions and (2) did not appear to be easy for the government officials to calculate. In fact, the officials came up with their own numbers for table 1. How sensitive are the benefits of the budget-based approach to estimation errors? Some analytical or simulation estimates of this sensitivity would be informative.

More broadly, institutional features are not emphasized. What led the contracting officials to select these particular projects for this pricing experiment? Were these settings where traditional approaches had worked reasonably well (say, because of few change orders or little interaction with other products)? Or were these settings where traditional approaches had led to unusual concerns about the efficiency of standard practice? Either way, what aspects of the proposed pricing scheme were thought to be important in the experiment? What provisions were made to evaluate the experiment? What institutional differences between the United States and Germany are important in understanding these choices? For example, how do product costing and subcontracting practices differ?

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[3] Given that the defense sample has more pension plans, the results in Thomas and Tung's table 3 need to be carefully interpreted. Suppose that the SFL, FR, and AM variables are drawn from some probability distribution for each plan. Since the contractor sample has twice as many plans on average, we would expect a greater range in these other variables even without any cost-shifting behavior. Order statistics are confounded with number of observations.

Concluding Thoughts

Industry studies in general, and study of the defense industry in particular, have a long history in economics, finance, accounting, and related fields. The three articles in this Forum concentrate on the possibility of "efficient" behavior in the defense industry. Reichelstein (1992) emphasizes contracting frictions, in the explicit form of private information in the hands of the producer. Thomas and Tung (1992) emphasize multiperiod considerations, in the explicit form of the timing of pension fund contributions. Rogerson (1992) emphasizes accounting, in the explicit form of product costing's impact on factor choice incentives through the medium of product-specific pricing arrangements.

This industry is unusual in its combination of a structured product market with administered prices, high technology and uncertainty, sprawling multiproduct firms, and regulation. It offers an unusual opportunity for the study of accounting. Rogerson (1992) responds to this challenge, and his analysis goes to the heart of interacting accounting and economic forces. The foundation of single-period, certain production carries the theme in concise fashion, but at a cost of holding the unusual features of the industry largely at bay. The multiperiod feature is emphasized in Thomas and Tung (1992), while holding accounting largely at bay. Contracting frictions are emphasized by Reichelstein (1992), but both industry structure and accounting are held at bay.

To illustrate, Rogerson's (1992) and Thomas and Tung's (1992) results are predicated on a firm having different revenue responses to product costs across their operations. This diversity is taken as a descriptively valid assumption, and it creates problems in the contracting relationships. Reichelstein's study provides a motivation for different revenue responses, but without introducing the possibility that diversity in these responses across products could lead to interactions with contracting frictions.

Each article offers a glimpse of accounting issues (be it pension reporting, budgeting, or product costing) in an unusual industry. Moving to the next stage of linking these glimpses to the larger body of accounting thought requires a more forceful role for the industry environment. What is accounting asked to do in this environment? What unusual pressures are brought to bear? What substitute and complement "instruments" are at work?

We are reminded of the "positive theory" theme of Watts and Zimmerman (1986) and its challenge to treat accounting choice as a dependent variable. That challenge amounts to a sophisticated revealed-preference exercise in which we try to understand accounting choice in its natural environment. Meeting that challenge in industry studies is likely to be difficult, but we require considerable industry specification and documentation to understand how accounting shapes and is shaped by its environment.

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A Perspective on Accounting for Defense Contracts

Frank R. Lichtenberg
Columbia University

THE Forum articles by Rogerson (1992) and by Thomas and Tung (1992) suggest that government contractors are able to shift some of the overhead and pension costs of their commerical operations to the government. A fairly direct implication of the cost-shifting hypothesis advanced by these authors is that government contractors face lower (private) costs of commercial business than other firms and may therefore be more profitable.

Rogerson (1992) makes a convincing theoretical case that the cost allocation rules used in government contracting enable and encourage contractors to shift some of the costs of their commercial operations to the government. Thomas and Tung (1992) provide persuasive empirical evidence that contractors shift pension costs to the government by overfunding pension plans when employees work on defense contracts and withdrawing excess pension assets when employees work on commercial business. Government contractors would therefore be more profitable, even if they earn merely normal profits on their government business.

Although there have been several major empirical studies of the profitability of government (especially defense) contracting, none of these has examined the profitability of contractors' commercial operations or their overall profitability. Using longitudinal data on almost 9,300 industry segments from the COMPUSTAT file, I test and find strong support for the hypothesis that government contractors are more profitable than other firms. According to my estimates, the profit rate (return on assets) of these contractors as a whole is 68 to 82 percent higher than that of other segments. The most government-oriented group is almost three times as profitable as noncontractors. These segments are also significantly less capital-intensive than noncontractors and segments that are less government-oriented.

I. The Cost-Shifting Hypothesis

Rogerson (1992) argues that the methods used by defense firms for calculating the cost of products—in particular, the allocation of overhead in proportion to directly charged labor use—enables these firms to shift overhead from commerical to defense

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business. Under this overhead allocation scheme, the firm's revenue from the government, R_1, is:

$$R_1=D_1+OH[D_1/(D_1+D_2)]+NP,$$

where D_1 and D_2 are the direct costs of government and nongovernment business, respectively; *OH* is overhead costs, that is, costs that cannot be directly assigned to either business; and *NP* is negotiated profit. One of Rogerson's main points is that $(dR_1)/(dD_1)>1$. By incurring an additional dollar of direct government costs, the firm can increase its government revenue by more than $1.00, since the share of overhead reimbursed by the government increases. Plausible parameter values indicate that increasing D_1 by $1.00 may increase the firm's profits by 20 to 40 cents, which should induce the firm to select a value of D_1 that is high, both absolutely and relative to the value of indirect (e.g., capital) costs. Rogerson argues that the overhead allocation rule provides firms with the incentive to "under-capitalize production of products with cost-sensitive revenues [e.g., defense items] and over-capitalize production of products with cost-insensitive revenues [e.g., commercial items]."

Thomas and Tung (1992) argue that government contractors are able to reduce their cost of doing nongovernment business by overfunding pension plans when employees work on defense contracts (these contributions are reimbursed by the government) and withdrawing excess pension assets when employees work on commercial business. Evidence suggests that the Department of Defense (DOD) faces considerable difficulty in reclaiming its share of any overfunding. Although, in principle, regulatory authorities such as the Defense Contract Audit Agency could prevent this cost shifting, they may focus their limited resources on more obvious abuses, such as the inclusion of nonexistent costs or costs that clearly belong to commercial activities.

Both articles suggest that the ability to shift costs from commercial to defense business should allow "mixed" firms (those with both kinds of business) to be more profitable than purely commercial firms. Rogerson (1992) observes that his analysis helps to explain why defense firms often seem to behave as though increased costs on defense contracts actually raise their profits. Thomas and Tung (1992) state that overfunding is "valuable" under cost reimbursement, presumably because it raises profitability. But the authors of both articles decline to draw the conclusion that mixed firms ("defense contractors") are more profitable than commercial firms.

Thomas and Tung (1992) are careful to mention that their "results do not prove systematic 'overcharging'" by defense contractors. Rogerson (1992) is less agnostic, claiming that "the defense industry as a whole probably earns zero economic profit over the long run." Although he offers no justification for this statement, it is likely predicated on the assumption that there are no long-run barriers to entry into the defense industry, and that entry (actual or potential) prevents incumbents from earning excess returns, notwithstanding their ability to shift costs to the government. However, this assumption should not be accepted uncritically. Since the defense industry is a highly regulated one it is not clear that barriers to entry are absent or insignificant, or that contractors cannot earn rents (such as the informational rents discussed by Reichelstein in this issue).

The government might allow defense contractors to earn a higher rate of return on their assets than other firms earn for several reasons. For example, the government may

Table 1
Aggregate Data on Total Sales and Government Sales, 1984–89

	All Segments		Government Contractors		
Year	N	*Total Sales*	N	*Total Sales*	*Government Sales*
1984	7,112	$3,468	689	$336	$ 74
1985	7,837	3,821	740	353	88
1986	8,591	3,997	799	369	102
1987	9,108	4,605	821	384	103
1988	9,599	5,169	833	402	104
1989	9,298	5,550	766	409	104

Source: COMPUSTAT industry segment file.

Note: Contractors are those segments with positive government sales. Sales data are in billions of current dollars.

wish to attract a "queue" of potential suppliers.[1] Also, potential suppliers may be heterogeneous with respect to the quality of goods and services they provide, and quality is not observable ex *ante* by the government. A number of models (see, e.g., Stiglitz and Weiss 1981) imply that the equilibrium price will be above the market-clearing price under these conditions; the government will find it optimal to pay a price above contractors' reservation price (and allow firms to earn higher returns than they could elsewhere).

The hypothesis that the profitability of defense contractors is higher than that of other firms, in part because of cost shifting by the former, is worthy of empirical investigation. Most of the remainder of this article will be devoted to testing this hypothesis econometrically with COMPUSTAT industry segment data.

II. Hypotheses About the Relative Profitability of Government Contractors

An important premise of both Rogerson's and Thomas and Tung's articles is that a nonnegligible fraction of the sales of government contractors is to commercial (nongovernment) customers; otherwise, contractors would lack the opportunity to shift overhead and pension costs from commercial to government business. The COMPUSTAT industry segment data analyzed indicate that this assumption is indeed valid: the unweighted and weighted (by total sales) mean ratios of government sales to total sales for contractors are 0.32 and 0.25, respectively (see table 1). Consequently, when evaluating the relative profitability of government contractors, it is important to distinguish between three different profitability concepts: π_1=profitability of government business done by government contractors; π_2=profitability of commerical business done by government contractors; and π_3=profitability of commercial business done by nongovernment contractors. We are interested in testing the null hypothesis $\pi_2=\pi_3$

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[1] In the classic two-sector labor market model of a developing economy formulated by Todaro (1969), urban employers offer an above-market-clearing wage and attract a queue of (unemployed) rural workers. The relationship between the government and the private sector is analogous.

against the (one-sided) alternative hypothesis $\pi_2 > \pi_3$, that commercial business done by government contractors is more profitable than similar business done by noncontractors (since contractors may shift commercial costs to government business).

The DOD has periodically conducted comprehensive studies of defense contractor profitability, but none of these has been concerned with the difference between π_2 and π_3. The most recent of these studies was the Defense Financial and Investment Review (DFAIR) completed in June 1985. With regard to profitability, the primary goal of DFAIR was to compare "profits realized on negotiated defense contracts with the profits realized on comparable commercial work" (DOD 1985, V-26). To accomplish this, the DOD asked its contractors to "isolate the profit achieved on negotiated defense contract [by] segregat[ing] and report[ing] operating results of various categories of business conducted within individual business segments" (V-26).[2] Most of the profitability analysis of DFAIR was devoted to determining the value of the following profitability difference:

$$D_{1.23} \equiv \pi_1 - [s\pi_2 + (1-s)\pi_3],$$

where s is the ratio of assets used in commercial business by government contractors to assets used in commercial business by all segments. As shown in table 1, the ratio of commercial sales by government contractors to commercial sales by all segments is about 6 percent, so $D_{1.23} \approx D_{1.3} \equiv \pi_1 - \pi_3$. The estimate of $[s\pi_2 + (1-s)\pi_3]$ used by DFAIR was the profitability of durable goods manufacturing published in the Census Bureau's *Quarterly Financial Report*. DFAIR found that during the period 1970–79, the average value of $D_{1.23}$ was positive but small; the profitability of negotiated defense contracts was 0.7 to 0.9 percentage points higher than the profitability of durable goods manufacturing. However, during 1980–83, the profitability differential was much larger—8.4 to 8.7 percentage points.[3] DFAIR argued that this was attributable to several "unusual" circumstances, including a large military buildup, a severe recession in the civilian economy, and inflation forecast errors in defense contracts that failed to anticipate rapid disinflation. DFAIR's overall conclusion was that the "profitability of defense contracts has not been unreasonable" (1985, IX-3).

DFAIR also contained a much more cursory examination of the profitability difference $D_{1.2} \equiv \pi_1 - \pi_2$, a comparison "of profitability for DOD business to profitability for commercial business within the same business segments" during the period 1977–83 (1985, V-43). The estimate of $D_{1.2}$ for all product groups combined was about 8 percentage points, but it was argued that this difference in average profitability was entirely attributable to a single product group—aircraft—for which the differential was 14 percentage points.

Under the hypothesis that contractors shift costs from commercial to government work, estimates of $D_{1.23}$ and $D_{1.2}$ are not a sufficient basis for determinig whether the government overpays and whether contractors earn excess returns. By shifting costs, contractors may earn above-normal returns on commercial work and normal returns on government business, so $D_{1.2}$ is clearly a downwardly biased estimate of the effect of government contracting on profitability.[4] We need to know not only whether $\pi_1 > \pi_2$ (and $\pi_1 > \pi_3$), but also whether $\pi_2 > \pi_3$. Unfortunately, this question was not directly examined by DFAIR or by previous DOD studies.[5]

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[2] Since a significant fraction of costs and assets are joint between government and commercial work, the validity of these "segregations" is questionable.

[3] DFAIR examined two different measures of profitability: return on assets and the ratio of "economic profit" to assets. Both measures yielded virtually identical estimates of the difference $D_{1.23}$ in both periods.

Although separate data on π_1 and π_2—the profitability of government and commercial business of contractors—is not available outside the DOD, it is possible to observe the overall profitability, π_{12}, of contractors (as well as of noncontractors). By definition, this is the weighted average of π_1 and π_2: $\pi_{12} \equiv [g\pi_1 + (1-g)\pi_2]$, where g is the share of contractor assets used in government business. We estimate that $g \approx 0.2$, so that $\pi_{12} \approx (0.2\pi_1 + 0.8\pi_2) = [\pi_2 + 0.2(\pi_1 - \pi_2)]$: π_{12} is predominantly determined by the profitability of contractors' commercial business.[6] The difference, $D_{12.3}$, between the mean overall productivity of government contractors and noncontractors is estimated as follows:

$$\begin{aligned} D_{12.3} &\equiv \pi_{12} - \pi_3 \\ &= [\pi_2 + 0.2(\pi_1 - \pi_2)] - \pi_3. \end{aligned}$$

DFAIR found that π_1 exceeded π_2 by 8 percentage points, but suggested that this was atypical. If $(\pi_1 - \pi_2) = 0.08$, then $D_{12.3} = (\pi_2 - \pi_3) + 0.016$: $D_{12.3}$ will overstate the difference between π_2 and π_3 by 1.6 percentage points. If it is instead assumed that $\pi_1 = \pi_2$, $D_{12.3}$ may be viewed as a consistent estimate of $(\pi_2 - \pi_3)$.

III. Empirical Analysis

Table 2 presents data on U.S. defense industry employment since 1940. Wartime peaks in defense employment reached 30 percent in 1943 (World War II), 8 percent in 1953 (Korean War), and 5 percent in 1968 (Vietnam War). Relative defense employment declined steadily from 1968–78, then a defense buildup began, first under President Carter and later under President Reagan. At present, about 3 million people (3 percent of the private labor force) are employed in the defense industry, a share that is lower than it has been since the early 1980s. With the apparent end of the Cold War, defense industry employment is expected to decline by about a third, to 2 million people, by 1997.

Table 1 contains aggregate data on total sales and government sales from the COMPUSTAT industry segment file for 1984–89.[7] In 1988, when the coverage of the file is greatest, 9,599 segments are represented. Of these, 833 (8 percent) had positive reported values of (domestic) government sales. The mean size (total sales) of these gov-

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[4] Such an approach is in some respects analogous to the classic analysis of the effects of unions on wages. Suppose that when some firms in an industry become unionized (and therefore have to pay higher wages), other firms raise their wages in an attempt to escape unionization. Clearly, the difference between union and nonunion wage rates understates the effect of unionization on wages.

[5] Although knowledge of $D_{1.23}$ and $D_{1.2}$ should allow one to make inferences about $\pi_2 - \pi_3$ in principle, the DFAIR estimates of $D_{1.23}$ and $D_{1.2}$ correspond to different periods. Also, the evidence on $D_{1.2}$ is of low quality because no numbers are presented, only a graph, so the power of any test about $\pi_2 - \pi_3$ would be quite low.

[6] As indicated, the (unweighted) mean ratio of government sales to total sales of government contractors is about 1:3; according to DFAIR, the assets/sales ratio is about twice as high in commercial business as in government business.

[7] The file contains data on a limited number of accounting variables for "industry segments" (which are similar to operating divisions) of publicly traded companies. See Lichtenberg (1991) for further description and analysis of this database.

Table 2
Defense Industry Employment, Fiscal Years 1940–93

Year	*Employees (in thousands)*	*Share**	*Year*	*Employees (in thousands)*	*Share**
1940	314	0.74	1967	3,100	5.15
1941	2,500	5.76	1968	3,174	5.17
1942	10,000	22.10	1969	2,916	4.64
1943	13,361	29.74	1970	2,399	3.78
1944	12,600	27.17	1971	2,031	3.20
1945	11,000	24.12	1972	1,985	2.99
1946	1,168	2.23	1973	1,850	2.68
1947	786	1.53	1974	1,860	2.64
1948	958	1.83	1975	1,800	2.64
1949	732	1.45	1976	1,690	2.37
1950	713	1.36	1977	1,730	2.35
1951	2,400	4.75	1978	1,765	2.29
1952	3,600	7.12	1979	1,860	2.35
1953	4,118	8.04	1980	1,990	2.47
1954	2,975	5.97	1981	2,085	2.49
1955	2,500	4.79	1982	2,310	2.77
1956	2,500	4.62	1983	2,530	3.04
1957	2,850	5.25	1984	2,785	3.19
1958	2,800	5.30	1985	3,100	3.47
1959	2,700	4.91	1986	3,315	3.63
1960	2,460	4.38	1987	3,365	3.59
1961	2,600	4.66	1988	3,310	3.45
1962	2,725	4.88	1989	3,295	3.36
1963	2,550	4.59	1990	3,150	3.18
1964	2,280	3.94	1991	3,100	3.16
1965	2,125	3.59	1992	2,925	2.94
1966	2,640	4.41	1993	2,646	2.61

Source: Defense Budget Project, which is based on DOD data and incorporates Defense Budget Plan estimates of the annual labor force decline after FY 1991.

* Share refers to the percentage of the U.S. private sector labor force employed in the defense industry.

ernment contractors is similar to that of all segments. The ratio of government sales to total sales of all segments is in the 2 to 2.5 percent range, which is about a third smaller than the average ratio of defense employment to total employment reported in table 2.[8] Lower labor productivity—sales per employee—in defense production than in civilian production could contribute to this discrepancy. In turn, lower labor productivity might be attributable to lower capital intensity—assets per employee—in defense production. Recall that Rogerson's (1992) model predicted such a difference in capital intensity. I return to this point later.

Let us define the share of government sales in total sales as $GOVSHR \equiv GOV/TOT$, where GOV denotes government sales and TOT denotes total sales. Table 1 shows that government sales account for about 20 to 30 percent of the total sales of government contractors. Properties of the frequency distribution of $GOVSHR$ among contractors other than its aggregate (weighted average) value are of interest. (The articles by Rogerson [1992] and by Thomas and Tung [1992] indicate that the firm's behavior may depend on its sales mix, *GOVSHR*, in a nonlinear fashion.) I ranked defense contractors by value of *GOVSHR* and grouped them into four quartiles of equal size; the mean values of *GOVSHR* for the quartiles are as follows:

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[8] Moreover, the government sales figure presumably includes sales to nondefense federal agencies and to state and local governments.

Quartile	*Mean* (GOVSHR)
1	1%
2	9%
3	36%
4	83%

The bottom quartile of government contractors (ranked by *GOVSHR*) derives only 1 percent of total revenues from government sales. The bottom half derives only 5 percent, and the bottom three-fourths, 15 percent. The roughly 200 most government-intensive segments derive 83 percent of revenues from government sales.[9] Most of the government's purchases are from segments that also sell—indeed, sell *more*—to commercial customers. These segments therefore have the opportunities and incentives described above to shift overhead and pension costs from commercial to government business.

The procedure for testing the hypothesis that government contractors are more profitable than other segments and, more generally, that profitability is an increasing function of *GOVSHR* involves the measure of profitability (denoted *PROFIT*) as *return on assets*: the ratio of operating profit (loss) to identifiable assets. Operating profit (loss) is "sales of the . . . industry segment minus its allocated share of operating costs and expenses (i.e., costs of goods sold; selling, general, and administrative expenses; and depreciation, depletion, and amortization) data.[10] Identifiable assets are the tangible and intangible assets that are used by, or directly associable with, the industry segment.[11]

Consider the following regression equation:

$$PROFIT_{ijt} = \alpha + \beta\ GOVPOS_{ijt} + u_{ijt}, \qquad (1)$$

where the subscript denotes segment *i* in industry *j* in year *t* ($t = 1984, \ldots, 1989$), and GOVPOS=1 if the segment had positive government sales, and zero otherwise. Then β may be interpreted as the (population) mean profitability of defense contractors minus the mean profitability of other segments, and an estimate of β can be used to assess the magnitude and significance of the profitability differential. But, for several reasons, ordinary least-squares estimation of equation (1) could yield a biased estimate of β. Suppose that, for reasons unrelated to government contracting, profitability tends to be (permanently) higher in some industries than in others. If the proportion of segments that are government contractors happened, by chance, to be higher in industries with exogenously higher profitability, the estimate of β from equation (1) would be biased

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[9] Rogerson (1992) notes that, in the last major statistical analysis by the DOD of all major defense contractors, the mean value of *GOVSHR* was 83 percent. Perhaps, then, the DOD would consider only the segments in the top quartile of our sample as "major" contractors.

[10] It appears that most firms do not include interest and taxes as operating expenses. In most cases, then, *PROFIT* is a pre-tax rate of return on assets. If interest were treated as an operating expense, the appropriate measure of profitability would be return on equity, the ratio of operating income to equity, where equity $\equiv$ assets $-$ debt. Segment-level data on equity and debt are not available.

[11] To reduce the influence of outliers, I eliminated observations for which $PROFIT < -1$ or $PROFIT > 1$.

Table 3

Estimates of the Parameter β from Equations of the Form

$PROFIT_{ijt}=\beta X_{ijt}+\alpha_j+\delta_t+u_{ijt}$

(*t*-statistics in parentheses)

Included Effects	X=GOVPOS	X=GOVSHR
6-year effects (total, 1984–89)	0.030 (9.11)	0.044 (6.42)
6-year plus 410 industry effects (within-industry)	0.036 (9.85)	0.067 (9.15)
6-year plus 6,601 segment effects (within-segment)	0.034 (6.50)	0.090 (9.81)

Note:
PROFIT=(operating income)/(identifiable assets);
GOVPOS=1 if government sales>0;
=0 otherwise;
GOVSHR=(government sales)/(total sales);
mean(*PROFIT*)=0.053; and
N=48,794.

upward. This bias can be eliminated, however, by including a complete set of "industry effects," that is, a separate dummy variable for each industry. Similarly, "year effects" can be included to eliminate bias arising from spurious covariance between *PROFIT* and *GOVSHR* in the time dimension. The revised model may be represented as follows:

$$PROFIT_{ijt}=\alpha_j+\delta_t+\beta\ GOVPOS_{ijt}+u_{ijt}. \qquad (2)$$

Another, even more general, alternative is to replace the approximately 400 industry effects (the α_j) with approximately 6,600 segment effects (Θ_i). When segment effects are included, the estimate of β is based entirely on the within-segment (not at all on the between-segment) relationship between *PROFIT* and *GOVPOS*. This model allows the average profitability of segments (over time) to vary, conditional on *GOVPOS*; it controls for the influence of any permanent, or slowly changing, determinants of profitability. The estimate of β from this model answers the question of what happens to a *given* segment's profitability when it *switches* from being purely commercial to being a mixed segment. I estimate three variants of the relationship between *GOVPOS* and *PROFIT*: one with year effects alone, one with both year and industry effects, and one with both year and segment effects. I also estimate similar relationships between *GOVSHR* (the ratio of government sales to total sales) and *PROFIT*. The coefficient on *GOVPOS* may be interpreted as the mean profitability difference between noncontractors and the "typical" government contractor (for whom *GOVSHR*≈32 percent), and the coefficient on *GOVSHR* may be interpreted as the profitability difference between noncontractors and a hypothetical segment with 100 percent government sales.

Estimates of the parameter β from equations of the form (2) are presented in table 3. All of the parameter estimates are positive and extremely significant, providing strong support for the hypothesis that the profitability of government contractors is substantially higher than that of other segments. The three different estimates of the

GOVPOS coefficient are fairly similar and suggest that the mean profitability of segments that do any business with the government is 3.0 to 3.6 percentage points higher than that of segments with no government sales, whose mean return on assets is about 4.4 percent. Hence, the profit rate of contractors is 68 to 82 percent higher than that of other segments.

As to the *GOVSHR* coefficients, the within-industry estimate is larger and more significant than the total estimate, and the within-segment estimate is larger and more significant than the within-industry estimate.[12] Since the within-segment model is more general than the others, in that the conditions under which it yields a consistent estimate of β are weaker than the conditions under which the other models yield consistent estimates, the within-segment estimate (0.090) will be assumed to be closest to the truth.[13] This implies that an increase of 50 percentage points in *GOVSHR* (e.g., from 0 percent to 50 percent) will increase return on assets by 4.5 percentage points—from 4.4 to 8.9 percent.

An implicit assumption underlying the regressions of *PROFIT* on *GOVSHR* in table 3 is that the relationship between these two variables is linear (and monotonic). The approximate validity of this assumption may be assessed by estimating a model in which *GOVSHR* is replaced by a set of dummy variables that indicate the location of each observation in the *GOVSHR* distribution. Estimates of the within-segment model with five such dummy variables are as follows:

GOVSHR range	*mean*(GOVSHR)	*mean*(PROFIT)*
$0\% < GOVSHR \leq 5\%$	2%	1.4%
$5\% < GOVSHR \leq 15\%$	9%	2.9%
$15\% < GOVSHR \leq 30\%$	21%	0.0%
$30\% < GOVSHR \leq 60\%$	44%	3.1%
$60\% < GOVSHR$	84%	8.2%

* Mean (*PROFIT*) refers to that of the specified group minus that of noncontractors. The standard error of each of these differences in means is approximately 0.1 percent.

None of the figures in the last column is negative, so none of the five groups of contractors has lower mean(*PROFIT*) than noncontractors do. Moreover, with the exception of the third group, mean(*PROFIT*) is strictly increasing with respect to mean(*GOVSHR*). Therefore, the assumption that profitability is a linear function of *GOVSHR* is supported even though not completely validated.[14]

IV. Potential Bias from Mismeasurement of Assets

It is conceivable that errors in measuring assets that are correlated with *GOVSHR* could bias estimates of the profitability differential β upward. Although the denominator of the profitability ratio allegedly includes intangible as well as tangible assets, it is possible that it fails to fully account for certain kinds of investments in intangible assets, such as R&D investment and contributions to political action committees (PACS). If this is the case, there is a distinction between measured profitability $\pi \equiv OPINC/A$ and "true" profitability $\pi^* \equiv OPINC/A^*$, where $OPINC$ = operating income, A = measured assets, and A^* = "true" assets. Suppose that the ratio of A^* to A is an increasing function of $GOVSHR$. In particular, suppose that:

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[12] This is somewhat unusual: often the size and significance of within estimates is *smaller* than that of total estimates. As Griliches and Hausman (1986) show, this may be because errors in variables biases are exacerbated in within models.

[13] This estimate is also the one most consistent with the *GOVPOS* coefficient estimates.

[14] Comparisons of the *median* profitability of these groups yielded results similar to the comparisons of means.

$$\ell n(A^*/A) = \Omega GOVSHR + \epsilon,$$

where $\Omega > 0$. Lichtenberg (1988, 1989b) presents evidence that the propensity to invest in R&D and to contribute to PACS is higher for government-oriented firms. For simplicity, let us ignore the possibility of nonpositive profits and assume that the relationships between (true and measured) profitability and $GOVSHR$ are also semi-logarithmic:[15]

$$\ell n\,\pi^* = \beta^* GOVSHR + u^*,$$
$$\ell n\,\pi = \beta GOVSHR + u.$$

The effect of $GOVSHR$ on true profitability is represented by β^*, while β represents its effect on measured profitability. It is straightforward to show that $E(\beta) = \beta^* + \Omega$; the estimate of β will be an overestimate of the true government/nongovernment profitability differential if the ratio of true to measured assets is higher in government-oriented firms.

One way to assess whether the estimates of β are, in fact, biased by asset mismeasurement (and, if so, to reduce or eliminate this bias) is to include an indicator of investment in possibly unmeasured assets as an additional regressor in equation (2). One indicator that can be constructed (for a subset of industry segments) is the ratio of (company-sponsored) R&D investment to sales. If present operating income includes returns to past R&D investments as well as returns to measured assets, one might expect this variable to have a significant positive coefficient in equation (2). In fact, however, the coefficient on R&D intensity was negative and highly significant. (The point estimate was −1.01; *t*-statistic, 8.77.) This may be attributable to the fact that firms "expense" their R&D investments, so higher R&D results in lower operating income. More importantly, the estimate of β was essentially unchanged after controlling for R&D.[16] Thus, although asset mismeasurement could theoretically bias the estimate of the government/nongovernment profitability differential upward, a limited attempt to correct for such mismeasurement produced no evidence that this is the case.

V. Capital Intensity of Defense Contractors

As noted earlier, Rogerson (1992) argues that the overhead allocation rule provides firms with the incentive to under-capitalize the production of defense items—to employ too little capital per worker—and to over-capitalize the production of commercial items. In this section, I examine differences in capital intensity between government

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[15] Although this assumption about strictly positive profitability is convenient, it may not be innocuous, for the following reason. If assets of government contractors are underestimated (to a greater degree than those of noncontractors), then their relative profitability will be overestimated when operating income is positive, but it will be *underestimated* when there are operating losses. Since operating income is more often positive than negative in practice, presumably the former bias dominates, and the net bias is positive.

[16] It was also a surprise to find that R&D intensity was significantly *negatively* correlated with *GOVSHR*.

contractors and other segments by estimating a model like equation (2) in which *PROFIT* is replaced by the logarithm of assets per employee, $\ell n(K/L)$. Rogerson's model does not appear to make an unambiguous prediction about the sign of this difference, since it is not clear *a priori* which effect—under- or over-capitalization—will dominate. One may interpret the following estimates as an indication of which effect (if either) dominates.

The point estimates (t-statistics) of β from within-industry regressions of $\ell n(K/L)$ on *GOVPOS* and *GOVSHR* are −0.112 (5.36) and −0.325 (7.31), respectively. Government contractors have significantly fewer assets per employee than other segments within the same industry. Further analysis reveals that the mean capital intensity of the bottom half (ranked by *GOVSHR*) of government contractors, whose mean(*GOVSHR*) is 5 percent, is not significantly different from that of noncontractors. In contrast, the mean capital intensity of the third and highest quartiles of contractors are 17 and 26 percent lower, respectively, than that of contractors. For these contractors, whose mean(*GOVSHR*) is 60 percent, the under-capitalization effect appears to be strongly dominant.

VI. Summary and Conclusions

Rogerson's (1992) article makes a convincing theoretical case that the cost allocation rules used in government contracting enable and encourage contractors to shift some of the costs of their commercial operations to the government. Thomas and Tung (1992) provide persuasive empirical evidence that contractors shift pension costs to the government by overfunding pension plans when employees work on defense contracts and withdrawing excess pension assets when employees work on commercial business. I have argued that this cost shifting results in lower (private) costs of commerical business for government contractors, which should therefore be more profitable than other firms even if they earn merely normal profits on their government business. Previous studies of the profitability of government contractors have focused on the profitability of their government business, and have essentially ignored the profitability of their commercial business (which is twice as large, on average). The cost-shifting hypothesis suggests that the (overall) profitability of defense *contractors* may be of greater interest and importance than the profitability of defense *contracts*.

Econometric analysis of annual data for the years 1983–89 for almost 9,300 industry segments provided strong support for the hypothesis that government contractors are substantially more profitable than other segments. The estimates indicate that the profit rate (return on assets) of contractors as a whole is 68 to 82 percent higher than that of other segments. The profitability of the most government-oriented—those for whom government sales accounts for an average of 84 percent of total sales—is almost *three times* as high as that of noncontractors. These estimates of profitability differentials might be biased upward because of asset mismeasurement, but a limited attempt to correct for such mismeasurement provides no evidence of a bias. There is also evidence that highly government-oriented segments are significantly less capital-intensive than less government-oriented segments and noncontractors.

In a previous article (Lichtenberg 1990), I argued that the effective rate of government subsidy to contractor-sponsored R&D is much larger than the apparent rate of subsidy. This article has provided empirical support for the hypothesis that the profits realized by government contractors may be higher than appearances (or previous DOD studies) would suggest. A speculative interpretation of these finding is that the DOD wants to provide generous subsidies and profits to contractors, but does not wish to *appear* to be doing so to members of Congress and the public. The extent to which DOD outsiders are deceived by these appearances is unknown; survey evidence reported in DFAIR indicates that twice as many DOD contract officers agree with the statement that "the profits earned by defense contractors are too high" as disagree with it (DOD 1985).

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Fraud Detection: A Theoretical Foundation

Ella Mae Matsumura
University of Wisconsin–Madison
Robert R. Tucker
University of Illinois at Chicago

SYNOPSIS AND INTRODUCTION: The 1987 Treadway Report recommended several ways the profession might enhance auditors' ability to detect fraud. The Auditing Standards Board implemented many of the recommendations in 1988 with nine new "expectation gap" pronouncements issued as SAS Nos. 53 through 61. These new standards clarify and extend an auditor's responsibility for (1) detecting and reporting errors, irregularities (including fraud), and illegal acts (SAS Nos. 53 and 54) and (2) assessing the internal control structure (SAS No. 55). The effect of recent and possible future increases in auditors' responsibility to deter and detect fraud warrants study.

To provide insight into the strategic interaction between a manager and auditor, we develop a theoretical foundation through game-theoretic analysis and economic experimentation. The game involves one decision by the manager and two by the auditor. The manager moves first, choosing a probability of committing fraud. The auditor, without observing the manager's choice, decides whether to perform tests of controls and then decides the level of detailed tests of balances. This second stage of testing allows the auditor to detect fraud with a probability that increases with the level of testing (up to a probability of less than 1). We solve for Bayesian Nash equilibria in this setting.

This study investigates the effects of four independent variables: (1) auditor's penalty, which reflects either a monetary loss (through lawsuits) or a loss of reputation from failure to detect fraud, (2) auditing standard requirements, which reflect the ability of auditing standard setters to

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increase auditors' responsibility for detecting fraud or other irregularities, (3) the quality of the internal control structure, which is represented by a distribution of unintentional clerical errors that the auditor must investigate to detect an irregularity, and (4) audit fee, which reflects increased competition in the market for auditing services. We examine the effect of these variables on: (1) tests of transactions and detailed tests of balances, (2) fraud detection, and (3) incidence of fraud.

The results of the economic experiment indicate that increasing the auditor's penalty decreased fraud, increased detailed tests of balances, decreased tests of transactions, and increased fraud detection. Increasing testing requirements increased audit costs, decreased discretionary testing, increased fraud detection, and decreased fraud commission. With strong internal control, auditors increased tests of transactions and detected fraud more frequently; managers committed fraud less frequently. Increasing the audit fee resulted in less fraud. The empirical results support a direct relationship between testing, fraud detection, and fraud prevention.

Two *caveats* are worth noting. Given our motivation for studying the interaction between manager and auditor, we frame the issue as fraud. However, the model actually encompasses all irregularities. Irregularities come in two varieties: fraud (misrepresentation of fact) and defalcations (misappropriation of assets). The situation modeled is sufficiently general to fit both types of irregularities, yet not so specific as to exclude either one. Management fraud possesses many unique features that are only implicit in the model (e.g., reporting). Hence, any generalizations should pertain to the detection of irregularities rather than to specific aspects of management fraud. A second *caveat* is that we focus solely on the economic implications of fraud in this study, and its ethical dimension is not explored.

Key Words: *Experimental economics, Fraud detection, Game theory, Theory development.*

Data Availability: *The data as well as the detailed instructions used in this study may be obtained from the authors on request.*

I. The Model

THE three branches of analytical research that were forerunners of this research are statistical decision theory, agency theory, and game theory. In statistical decision theory models, the auditor plays against nature rather than a strategic player, so that the probability of an error is exogenously specified (see, e.g., Kinney 1975; Menzefricke 1984). More recently, researchers have used game theory to capture both the auditor's sampling risk and interaction with a strategic opponent. Some examples include Fellingham and Newman (1985), Fellingham et al. (1988), Fellingham et al. (1989), Newman and Noel (1989), Hansen (1990a, 1990b), Patterson (1991a, 1991b), and Shibano (1990). Our study falls in this category and is unique in that the auditor explicitly designs the audit strategy to test for fraud. The audit strategy allows the realistic feature of two-stage sampling.

Other attempts at modeling the interaction between the auditor and manager have used an agency (optimal contracting) framework. For example, Antle (1982) and Baiman et al. (1987) demonstrate the demand for an audit in a three-person game that includes the owner as well as the manager and auditor. In these studies, auditing yields perfect knowledge; hence, there is no sampling risk.

The sequence of events in our model is shown in figure 1. At the beginning of the game, managers and auditors have an identical prior distribution over the current year's level of internal control (IC), the percentage of unintentional errors. The degree to which auditors can rely on internal control depends on this error rate. By assessing contol risk through tests of transactions, the auditor might reduce control risk and better plan the detailed tests of balances. For tractability, we assume the IC distribution is normal, with known mean μ and variance σ^2.

The game involves one decision by the manager and two by the auditor. The manager moves first, choosing either to commit fraud ($t=\hat{t}>0$) or not ($t=0$). We include the possibility of a randomized strategy, in which the manager commits fraud with probability p. The percentage of errors, y, is the percentage of clerical errors, IC, plus the percentage of intentional errors, t. Since t is a constant, y has a normal distribution with mean $\mu+t$ and variance σ^2.

The next decision is made by the auditor, who must decide whether to perform tests of transactions (test 1) without knowing the manager's choice. The choice is between no sampling and verifying the percentage of errors in the population. If the auditor chooses not to sample, the sample-size decision at the second stage of testing is based on the auditor's "prior" belief about the probability of fraud.

Performing test 1 does not allow the auditor to distinguish between unintentional and intentional errors.[1] However, knowing the percentage of errors enhances the auditor's ability to infer whether fraud exists, and therefore bears on the decision regarding test 2. The auditor's second decision is whether to perform a high or low level of detailed tests of balances (test 2). In our model, an auditor can detect fraud only by performing test 2. However, even when testing at the high level, the auditor has less than a 100 percent chance of detecting existing fraud.[2]

The manager and auditor receive a fee for their services. The auditor deducts sampling costs from the audit fee. If the auditor detects fraud, there is a bonus of A_g, which can be interpreted as either the increased profit from the necessary extra hours worked or the expected value of long-term increased profitability from enhanced reputation. If the auditor does not detect fraud when it exists, there is a positive probability that it will be revealed in the future, with an accompanying penalty. Thus, A_l represents the expected value of long-term effects of not detecting existing fraud in the current period. The manager may escape retribution by leaving the labor market or the country, and thus shows a positive expected value of long-term benefits if fraud is not detected in the current period.

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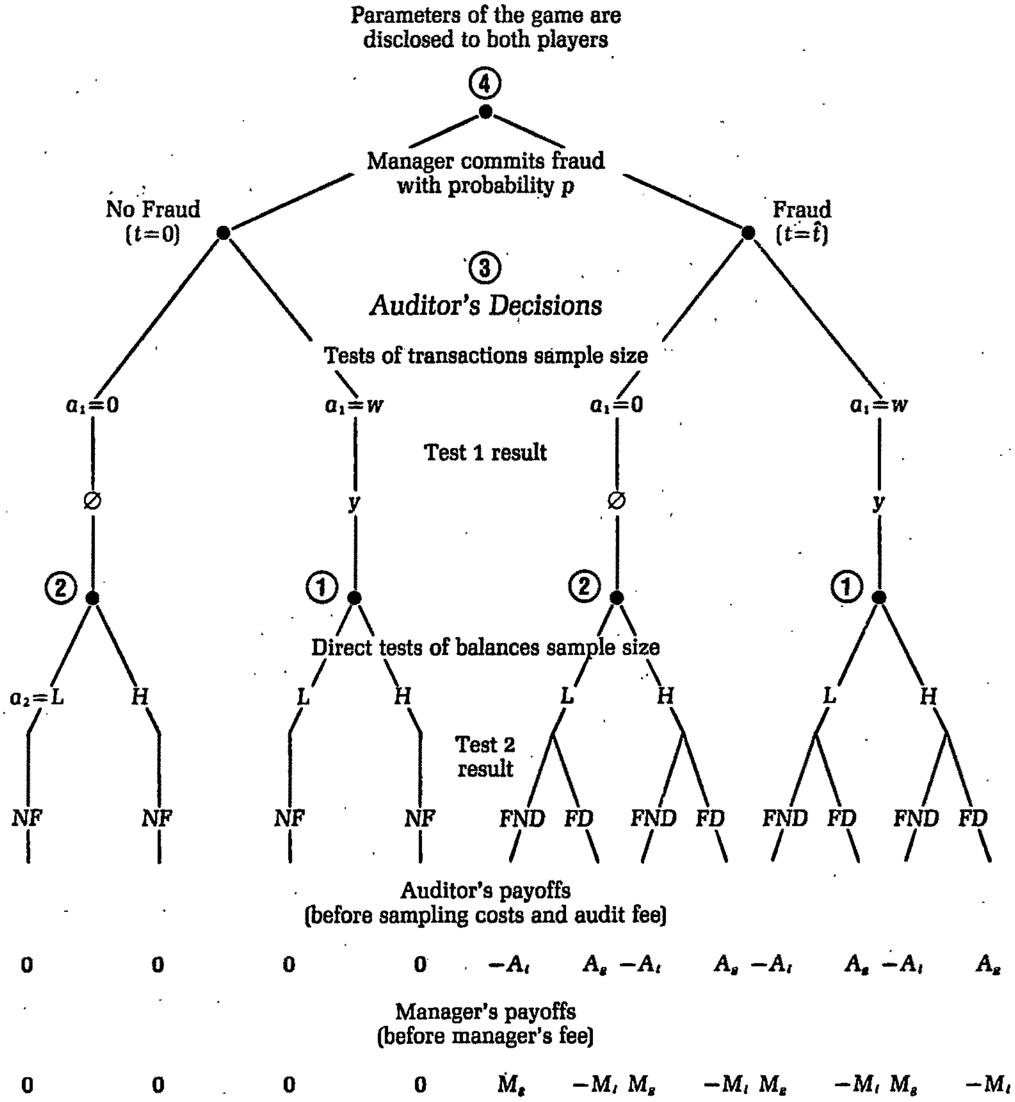
[1] Although auditors may sometimes discover fraud while performing tests of controls, this is not the purpose of such tests (AICPA 1990, AU section 320.06), and we do not incorporate that possibility into the model or experiment. According to the second standard of field work (AICPA 1990, AU section 150.02), the purpose of obtaining an understanding of interal control is to determine the nature, timing, and extent of tests to be performed.

[2] In practice, evidence might lead an auditor to suspect fraud erroneously. We assume the cost of avoiding false accusations is incorporated into the cost of test 2. Therefore, test 2 is conclusive and does not result in false positives.

Figure 1
Tree Diagram of Game Sequence


Parameters of the game are disclosed to both players
④
Manager commits fraud with probability p
No Fraud (t=0)
Fraud (t=t̂)
③
Auditor's Decisions
Tests of transactions sample size
a₁=0
a₁=w
a₁=0
a₁=w
Test 1 result
∅
y
∅
y
②
①
②
①
Direct tests of balances sample size
a₂=L
H
L
H
L
H
L
H
Test 2 result
NF
NF
NF
NF
FND
FD
FND
FD
FND
FD
FND
FD
Auditor's payoffs (before sampling costs and audit fee)
0 0 0 0 −A_l A_g −A_l A_g −A_l A_g −A_l A_g
Manager's payoffs (before manager's fee)
0 0 0 0 M_g −M_l M_g −M_l M_g −M_l M_g −M_l

Note: The circled numbers at the various nodes pertain to the Nash equilibria and are explained in the text. Other definitions are:

t=the level of fraud, either 0 or $\hat{t}>0$;
a_1=the number of items sampled in test 1 to detect compliance deviations;
w=the entire test 1 population;
$\varnothing$=no evidence obtained because no items were sampled;
y=actual percentage of errors in the population, $y \sim N(\mu+t, \sigma^2)$;
a_2=the number of items sampled in test 2 to assess whether the manager committed fraud;
L=low sample size for test 2;
H=high sample size for test 2;
NF=no fraud;
FND=fraud exists but is not detected by the auditor;
FD=fraud is detected by the auditor;
A_l=loss for failing to detect fraud;
A_g=gain from detecting fraud;
M_g=manager's gain for successfully concealing fraud; and
M_l=amount of manager's loss resulting from auditor's detection of fraud.

The manager's and auditor's strategies form a Nash equilibrium if the auditor does not wish to deviate from his or her strategy, given the manager's strategy, and vice versa. The Nash (subgame perfect) equilibria are derived through backward induction beginning at the nodes designated by a circled 1 in figure 1. The auditor's optimal response is derived by assuming the players have followed the path leading to the nodes. The analysis then proceeds to the nodes designated by a circled 2; the optimal response at those nodes is determined, and so forth. Definitions of the variables appear in figure 1. Propositions 1 and 2 below characterize the auditor's and manager's optimal strategies. Technical statements of the propositions, as well as their proofs, appear in the appendix.

Proposition 1. For a given level of internal control and a given prior probability p that the manager commits fraud, the auditor's optimal strategy is among the following:

1. Do not perform test 1 and perform test 2 at a low level.
2. Perform test 1 and learn y, the percentage of errors in the population. If y is high, perform test 2 at a high level; otherwise, perform test 2 at a low level.
3. Do not perform test 1 and perform test 2 at a high level.

Generally speaking, if the manager commits fraud infrequently (low p) then the auditor prefers strategy 1. However, if p falls in an intermediate range, the auditor prefers strategy 2, and at high p values, strategy 3 becomes optimal. Tests of details of balances typically exceed the cost of tests of transactions. Thus, these results imply that the higher the frequency of fraud commission, the more the auditor typically spends on testing for fraud.

Proposition 1 states the auditor's optimal strategy, given the manager's decision (p, the probability of fraud commission). Proposition 2 derives the probability of fraud commission that maximizes the manager's utility given the auditor's anticipated strategy response.

Proposition 2. The manager's optimal choice p^* at the beginning of the game (fig. 1, node 4) depends on the auditor's anticipated strategy, as follows:

1. Suppose the auditor follows strategy 1 (no test 1, low test 2). The manager commits fraud with a probability of 1 if:

$$\frac{\text{gain from concealed fraud}}{\text{loss from detected fraud}} > \frac{\text{probability of detection}}{\text{probability of nondetection}}.$$

   Otherwise, the manager never commits fraud. More precisely, the manager commits fraud with a probability of 1 if:

$$\frac{M_g}{M_l} > \frac{1-Q_1}{Q_1}, \tag{1}$$

   where Q_1 is the probability of not detecting existing fraud if the auditor uses strategy 1.

2. Suppose the auditor employs strategy 3 (no test 1, high test 2). The manager commits fraud with a probability of 1 if:

$$\frac{M_g}{M_l} > \frac{1-Q_2}{Q_2}. \tag{2}$$

Otherwise, the manager never commits fraud. The inequality is similar to that in inequality (1), but with Q_1 replaced by Q_2, the probability of not detecting fraud with strategy 3.

3. Suppose the auditor employs strategy 2 (observe y and evaluate whether to perform test 2). The manager's optimal choice is characterized by the first-order condition in equation (A5) in the appendix.

Inequalities (1) and (2) show that a manager can be deterred from committing fraud by decreasing the rewards from fraud, increasing the penalty of detection, or increasing the ratio of detection to nondetection probabilities. The probability of detection with strategy 3 (high test 2) equals or exceeds that of the other two strategies. The evaluation of the manager's optimal choice is more complicated in case 3 of Proposition 2 because the auditor's decision to perform test 2 depends on y, the uncertain percentage of errors in the population.

The results in Propositions 1 and 2 permit us to derive the Nash equilibria for the game. We provide an informal statement of Proposition 3 below and a more precise statement in the appendix.

Proposition 3. The Nash equilibria (auditor strategy, manager's probability of committing fraud) of the game are as follows:

1. The auditor uses strategy 1 (no test 1, low test 2) and the manager does not commit fraud. This is an equilibrium only if inequality (1) in Proposition 2 does *not* hold.
2. The auditor uses strategy 3 (no test 1, high test 2) and the manager commits fraud (with a probability of 1). Condition (2) in Proposition 2 is necessary for this equilibrium.
3. The auditor uses strategy 2 (test 1, conditional test 2) and the manager commits fraud with a probability that maximizes his or her expected return, given that the auditor is using strategy 2.

In case 1 of Proposition 3, the manager does not commit fraud and the auditor samples as little as allowed. This pair of strategies cannot form an equilibrium if the auditor's low level of test 2 is zero because the probability of detecting fraud is then zero. In case 2, with certainty, the manager commits fraud and the auditor uses as high a level of fraud-detection testing as possible.

II. Example

The example in this section illustrates the effect of changes in parameters on the auditor's decisions. Both practicality and intuition played a role in selecting the parameter values shown in table 1. We chose the internal control means (i.e., the percentage of clerical errors, 0.10 and 0.25) to be sufficiently different and large enough so that an intentional error of 0.04 could conceivably be hidden. The level of fraud, 0.04, was fixed for tractability. The standard deviations (0.02 or 0.05) were made proportional to the means, which is consistent with the idea that a poorer internal control system produces greater uncertainty about the error rate. An additional advantage is that the change in variance affects the manager's ability to conceal fraud and therefore also affects the value to the auditor of the tests of transactions, test 1.

Fraud could be detected only with test 2. The maximum sample size for test 2 was set so that, given the intentional error of 0.04, the probability of detecting existing fraud

Table 1
Parameter Choices and Other Definitions

Constants		*Variations*	
Intentional error:	$\hat{t}=0.04$	Audit fee$=200$ or 500	
Test 1 population:	$w=1{,}000$	Auditor's loss from undetected fraud:	$A_l=0$ or 800
Cost for test 1:	$c_1=0.03$	Low sample size for test 2:	$L=0$ or 15
Cost for test 2:	$c_2=8$	Internal control distribution$=N(0.10, 0.02^2)$ or $N(0.25, 0.05^2)$	
High sample size for test 2:	$H=30$		
Auditor's gain from detecting fraud:	$A_g=600$		
Manager's gain from successful fraud:	$M_g=360$		
Manager's loss from unsuccessful fraud;	$M_l=142$		
Manager's fee$=200$			

Other Definitions

IC$=$level of internal control represented by the percent of clerical errors;
c_i=cost of a sample unit in test i;
Q_1=probability of not detecting fraud if $a_2=L=(l-\hat{t})^L$;
Q_2=probability of not detecting fraud if $a_2=H=(l-\hat{t})^H$;
$\Phi_t=\text{Prob}(y<K \mid t=\hat{t})$; and
$\Phi_o=\text{Prob}(y<K \mid t=0)$.

was still less than 1. More specifically, the probability of detecting existing fraud with the maximum level of test 2 was approximately 0.71. In accordance with practice, we set the tests of transactions cost (test 1) at less than the detailed tests of balances cost (test 2). Our costs per sample were 0.03 for test 1 and 8 for test 2; in conjunction with the permitted sample sizes, the total costs were 30 for test 1 and either 120 or 240 for test 2. The relationship between the two tests, their sequencing in the audit, and the uncertainty of detecting fraud due to sampling risk also stem from practice (Arens and Loebbecke 1988, 323). Also, in conformance with practice, the total cost of testing was generally less than either the audit fee (200 or 500) or the difference in payoff from detecting or not detecting existing fraud [1,400=600−(−800)].

Experimentally, we wanted the manager to have incentives to commit fraud so that we could observe the auditor's reaction to potential fraud. We therefore dramatically increased the manager's typical payoff (from 200 to 560) if his or her fraud went undetected; we also decreased the manager's payoff (from 200 to 58) if the fraud was detected. Given this set of parameters, which we believe are reasonable at least in a relative sense, we solved for the remaining variables so that some of the cells would have an equilibrium when the auditor used strategy 2.

With the example's equilibria shown in table 2 and the accompanying analysis, we explore the effects of changes in auditor's penalty, minimum required testing, and quality of internal control. The second column in table 2 shows the range of values of p for which each auditing strategy is optimal. The manager's optimal strategy, p*, given the auditor's strategy, is also shown. When the value of p* falls within the specified range for p, then p* and the associated strategy for the auditor form a Nash equilibrium. We identify these p* values with double asterisks in table 2. Table 3 summarizes the predictions developed in the following subsections.

Increases in Auditor's Penalty

The effects of changes in auditors' penalties warrants investigation. The Senate Subcommittee on Reports, Accounting and Management (1977, 19) recommended that the ability of investors to collect damages from auditors be increased to improve audit quality, and during the past 15 years courts have imposed higher penalties on auditors for substandard work. At the same time, the Auditing Standards Board has increased auditors' responsibility for detecting fraud and therefore their exposure to such legal penalties and the expected penalty for substandard work.

The analysis models the effect of these positions by varying A_f, the loss to the auditor for failing to detect existing fraud. A_f has two levels, 800 and 0. A level of 0 is consistent with the position that auditors are not responsible for detecting fraud. A level of 800 is consistent with the position that the fraud may ultimately be revealed, with the auditor suffering either a monetary loss (through lawsuits) or a loss of reputation.

Observe the effect of increasing penalties by comparing cases 1 with 3, 2 with 4, 5 with 7, and 6 with 8 in table 2. The equilbrium values of p in these comparisons are either the same or lower when the auditor's penalty increases,[3] which suggests that as the penalty increases, managers commit less fraud, presumably in anticipation of increased fraud-detection testing by the auditor.

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[3] When there are two possible equilibria in a case in table 2, the manager's expected return is higher when the auditor uses strategy 2. In such cases, we expect the manager to play that equilibrium.

Table 2
Solutions to Example

Auditor's Strategy (given p, the manager's randomized probability for fraud)	*Range of Values for Optimal Auditing Strategy*	*Manager's Optimal Strategy, p**	*Expected Returns (before fees)*	
			Auditor	*Manager*
Case 1: $A_l=800$, $L=0$, *and* $H=30$; $\mu=0.10$, $\sigma=0.02$				
Strategy 1:	$p\epsilon[0, 0.085]$	1.00		
Strategy 2:	$p\epsilon[0.09, 0.65]$	0.275**	−104.0	15.1
Strategy 3:	$p\epsilon[0.66, 1.0]$	1.00**	−51.0	5.5
Case 2: $A_l=800$, $L=0$, *and* $H=30$; $\mu=0.25$, $\sigma=0.05$				
Strategy 1:	$p\epsilon[0, 0.19]$	1.00		
Strategy 2:	$p\epsilon[0.20, 0.32]$	0.17		
Strategy 3:	$p\epsilon[0.325, 1.0]$	1.00**	−51.0	5.5
Case 3: $A_l=0$, $L=0$, *and* $H=30$; $\mu=0.10$, $\sigma=0.02$				
Strategy 1:	$p\epsilon[0, 0.32]$	1.00		
Strategy 2:	$p\epsilon[0.33, 0.77]$	0.40**	11.8	38.1
Strategy 3:	$p\epsilon[0.77, 1.0]$	1.00**	184.0	5.5
Case 4: $A_l=0$, $L=0$, *and* $H=30$; $\mu=0.25$, $\sigma=0.05$				
Strategy 1:	$p\epsilon[0, 0.55]$	1.00		
Strategy 2:	$p\epsilon[0.56, 0.57]$	0.39		
Strategy 3:	$p\epsilon[0.58, 1.0]$	1.00**	184.0	5.5
Case 5: $A_l=800$, $L=15$, *and* $H=30$; $\mu=0.10$, $\sigma=0.02$				
Strategy 1:	$p\epsilon[0, 0.22\}$	1.00		
Strategy 2:	$p\epsilon[0.23, 0.54]$	0.40**	−148.0	8.8
Strategy 3:	$p\epsilon[0.55, 1.0]$	1.00**	−51.0	5.5
Case 6: $A_l=800$, $L=15$, *and* $H=30$; $\mu=0.25$, $\sigma=0.05$				
Strategy 1:	$p\epsilon[0, 0.34]$	1.00		
Strategy 2:	None	0.24		
Strategy 3:	$p\epsilon[0.35, 1.0]$	1.00**	−51.0	5.5
Case 7: $A_l=0$, $L=15$, *and* $H=30$; $\mu=0.10$, $\sigma=0.02$				
Strategy 1:	$p\epsilon[0, 0.806]$	1.00		
Strategy 2:	None	0.54		
Strategy 3:	$p\epsilon[0.81, 1.0]$	1.00**	184.0	5.5
Case 8: $A_l=0$, $L=15$, *and* $H=30$; $\mu=0.25$, $\sigma=0.05$				
Strategy 1:	$p\epsilon[0, 0.806]$	1.00		
Strategy 2:	None	0.60		
Strategy 3:	$p\epsilon[0.81, 1.0]$	1.00**	184.0	5.5

Note: The double asterisks for values of p^* denote a Nash equilibrium with the associated auditing strategy. For strategy 1, $a_1=0$, $a_2=L$; for strategy 2, $a_1=w, a_2(y)$; for strategy 3, $a_1=0$, $a_2=H$. The mean of the internal control is designated by μ; the standard deviation, by σ.

Turning to the auditor's strategies, we see that strategy 2 is an equilbrium strategy in more cases in table 2 when the penalty increases, so the amount of testing in test 1 should increase. The effects on the ranges of p for which each strategy is optimal for the

Table 3
Directional Hypotheses

Independent Variables	Dependent Variables				
	Fraud Committed	*Test 1 Percentage*	*Test 2 Percentage*	*Fraud Detected*	*Amount Spent*
Audit fee	−	+	+	+	+
Auditor penalty	−	+	+	+	+
Minimum required testing	+	−	−	+	?
Internal control	−	+	+	+	?

Note: The model assumes the two parties are risk neutral, so audit fee does not affect any of the dependent variables. The predictions for this variable reflect the position advanced by some within the accounting profession. A plus sign indicates that the dependent variable is positively associated with the independent variable; a minus sign indicates a negative association; a question mark indicates an ambiguous association.

Table 4
Effects of Changes in Manipulated Variables on Ranges of p

Variable Increased	*Auditor Strategy*	*Cases Compared*			
		3 with 1	*4 with 2*	*7 with 5*	*8 with 6*
A_l *(auditor penalty)*	1	−	−	−	−
	2	+	+	+	None
	3	+	+	+	+
		1 with 5	*2 with 6*	*3 with 7*	*4 with 8*
L *(minimum required testing)*	1	+	+	+	+
	2	−	−	−	−
	3	+	−	−	−
		1 with 2	*3 with 4*	*5 with 6*	*7 with 8*
μ,σ *(mean and s.d. of internal control)*	1	+	+	+	None
	2	−	−	−	None
	3	+	+	+	None

Note: A minus sign indicates that the range decreased as the variable increased; a plus sign indicates that the range increased as the variable increased. The case numbers and the auditor strategy numbers are those used in table 2.

auditor as the manipulated variables are increased are shown in table 4. For example, as A_l increases, the ranges in which strategies 2 and 3 are optimal increase, while those for strategy 1 decrease. This suggests that if the manager-subjects do not play equilibrium p's, there will be more testing (test 1, the high level of test 2, and overall) at the higher penalty level if the auditors respond optimally to the managers' play.

Table 2 also shows that the auditor employs strategies 2 and 3 at lower values of p when the penalty is high. Furthermore, for a fixed value of p, an increase in the auditors' penalty causes a decrease in the threshold value for choosing a high level of test 2 with strategy 2. This implies that, as the auditors' penalty increases, the probability of detecting fraud, given that it exists, will increase, if all other parameters remain fixed.[4]

Increases in Minimum Required Testing

As noted previously, recent SAS Nos. 53–56 and 60 (AICPA 1988a, 1988b, 1988c, 1988d, 1988e) stem from the Treadway Report recommendations and increase auditors' responsibility for detecting irregularities and illegal acts, assessing and reporting on internal control, and performing analytical review procedures. We model and test the effect of increases in auditors' minimum level of testing to determine whether a favorable effects on fraud detection and prevention exist.

The analysis models an increase in the stringency of auditing standards by permitting L, the minimum required sample size for test 2, to be either 0 or 15. Thus, when test 2 sampling is required, $L=15$ and $H=30$, which yields the following respective probabilities of fraud detection:

$$1-(1-0.04)^{15}=0.46,$$

and

$$1-(1-0.04)^{30}=0.71.$$

Note the effect of increasing the minimum testing requirements by contrasting cases 5 with 1, 6 with 2, 7 with 3, and 8 with 4 in table 2. Strategy 2 is an equilibrium strategy in fewer cases when minimum required testing increases, so the amount of testing in test 1 should decrease. This follows because investing in test 1 $[c_1w=(0.03)(1000)=30]$ provides information on the wisdom of investing in test 2. Hence, the greater the differential sampling cost of test 2, the more important is test 1. When L is 0, the differential cost is $c_2H-c_2L=(8)(30)-(8)(0)=240$; when L is 15, the differential cost is $(8)(30)-(8)(15)=120$. Therefore, when the minimum testing requirement increases, strategy 2 becomes optimal only at higher values of p, and the range of values of p for which strategy 2 is optimal becomes smaller.

When the auditor performs test 1 in the required testing cases ($L=15$), the threshold value for choosing the high level of test 2 is higher than in the cases without required testing[5] ($L=0$) for fixed p. Thus, as L increases, we expect less high-level testing in test 2 when strategy 2 is used. In addition, as shown in table 4, the ranges in which strategy 3 is optimal decrease as L increases. If the manager-subjects do not play equilibrium strategies, we expect less high-level testing of test 2. Note, however, that increasing L requires a minimum sampling cost of $(8)(15)=120$ for each game, which may cause the total sampling cost to increase.

The probability of fraud detection increases as L increases when auditors employ strategies 1 and 2 optimally.[6] However, if auditors choose strategy 3 optimally, then the

[4] We establish this comparative static result in the appendix.

[5] In the appendix, we derive the result that the partial derivative of K with respect to L is positive for the parameters in this study.

[6] This is derived in the appendix.

probability of fraud detection remains constant as L increases. If the auditor uses strategies 1 or 3, then the manager's choice of p remains unchanged despite increases in L (for the parameters used in this study). However, the manager's choice of p increases as L increases if the auditor uses strategy 2, since the auditor does less high-level testing.

Increases in Quality of Internal Control

The Treadway Commission made several recommendations to public companies and public accountants that emphasized the importance of the quality of the internal control structure in preventing, detecting, and deterring fraud, and SAS Nos. 55 and 60 expand auditors' data-gathering requirements concerning internal control. A primary objective for including this variable is to determine the role that the internal control structure plays in preventing fraud. A secondary objective is to investigate the effect of internal control on the nature of the tests that auditors perform. The difference in costs between tests of transactions (test 1) and detailed tests of balances (test 2) provides the economic rationale for greater use of test 1 when internal control is strong.

The model represents internal control as the percentage of clerical errors, which are assumed to be normally distributed with mean μ and variance σ^2. In the experiment, μ has two levels, 0.10 and 0.25. The better control system has a normal distribution $N(0.10, 0.02^2)$ whereas the poorer system is distributed $N(0.25, 0.05^2)$.

Observe the effect of strengthening internal control by comparing cases 1 with 2, 3 with 4, 5 with 6, and 7 with 8 in table 2. At the better internal control level (i.e., $\mu = 0.10$), test 1 is more cost effective, and the result is more equilibria involving strategy 2. Note that auditors employ strategy 2 over a larger range, including both higher and lower values of p. When internal control is poorer, the auditor begins to use strategy 3 (skipping test 1) at lower values of p. Thus, as internal control worsens, we expect less use of test 1 and more use of the high level of test 2. The level of internal control does not affect the probability of fraud detection in strategies 1 and 3, but the probability of fraud detection decreases as internal control worsens in strategy 2.[7]

When there are two possible equilibria in a case shown in table 2, the manager's expected return is higher with the equilibrium in which the auditor uses strategy 2. Given this, we expect p to increase as the internal control structure becomes weaker.

Increases in Audit Fee

With the assumption of risk-neutrality and complete information about players' utility functions, changes in the manager's salary or the audit fee have no effect analytically on the amount of testing or other variables. Therefore, the model suggests that the parameter choice for audit fee is irrelevant. However, the experiment, like the professional arena, is a multiperiod setting where players do not know each other's utility functions. Some members of the profession have argued that intense competition places downward pressure on audit fees and that firms may reduce audit work in an effort to maintain profit margins, which results in substandard auditing (AICPA Cohen Commission Report 1978, xxx). The converse of this argument implies that increasing audit fees should better enable auditors to meet or exceed auditing standards. The directional hypotheses corresponding to these arguments are shown in table 3; increases in audit fees should increase sampling and the percentage of fraud detected, and thus decrease fraud commission.

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[7] This is established in the appendix.

The difference between the model and experimental setting and the professional controversy justify including audit fee as a treatment variable. It permits an evaluation of the irrelevance of our choice of audit fee level to subjects' decision making.

III. The Experiment

To develop a mathematical model, one faces limitations necessary to achieve tractability. Of course the experimental setting also imposes limitations, but the constraints are different. Rather than constrain the experiment to reproduce the single-period analytical model literally, we structured the interaction between the manager and the auditor in a multiperiod setting with incomplete information regarding subjects' utility functions. This environment enables the auditor to develop a reputation capable of deterring fraud (Kreps and Wilson 1982). Further, the managers' decisions endogenously determine the audit risk faced by the auditor. Hence, the experiment augments the analysis and provides a test of the sensitivity of the analytical predictions to the assumptions.

For a review of several studies that address auditing issues by using economic experimentation, see Smith et al. (1987), Berg et al. (1990), or Dopuch and King (1991). Most prior studies involving auditor/client interactions have been in the area of agency theory, signalling, or auditor-client fee negotiations. This study is based on a game-theoretic model of the strategic interaction between a manager and an auditor.

The remainder of this section describes the statistical design of the experiment, the events within each experimental game, the subject pool, the training session, and the neutral terminology used in the instructions. We study the effects of four independent variables: audit fee, auditor's penalty, minimum required audit testing, and quality of internal control on five dependent variables: fraud commission, tests of transactions, tests of details of balances, fraud detection, and total amount spent on testing. Each of the independent variables has two levels, producing a 16-cell within-subject design depicted in table 5.

The data set of 136 observations consists of eight or nine independent replications for each of the 16 cells (see table 5). One observation represents the mean of a 40-game sequence played by the same auditor/manager pair. Each sequence was conducted over a computer network, and included the following order of events:

1. *Presequence Preliminaries.* The subjects completed four sequences of 40 to 45 games in each 2½ hour session.[8] At the beginning of each session, subjects drew lots to determine their role as auditor or manager. Prior to each sequence, sub-

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[8] Uncertainty regarding the length of the sequence (i.e., 40–45 games) served to reduce potential end-game effects. Finite-horizon games with complete information are often criticized by a backward induction argument, which predicts that a repeated finite game may "unravel" to a single-period game. This is an experiment with incomplete information regarding other subjects' utility functions and with uncertainty regarding the final period. Hence, the process does not necessarily unravel.

Even in a complete information game with a definite, finite horizon, considerable experimental evidence exists that is inconsistent with complete unraveling (see Kreps 1990, 514–15). For other empirical evidence that is inconsistent with unraveling in complete or incomplete information settings, see Camerer and Weigelt (1988), Kachelmeier (1992), and Finley et al. (1990). Graphs of the intrasequence decision making (i.e., fig. 3) show no directional shifts toward the end of the 40-game sequence.

Table 5
Description of Cell Parameters

Cell Number	*Number of Observations*	*Audit Fee*	*Auditor Penalty*	*Testing Options*	*IC Error Distribution*
1*	9	500	800	0/30	$N(10,2^2)$
2**	8	500	800	0/30	$N(25,5^2)$
3**	8	500	0	0/30	$N(10,2^2)$
4*	9	500	0	0/30	$N(25,5^2)$
5**	8	500	800	15/30	$N(10,2^2)$
6*	9	500	800	15/30	$N(25,5^2)$
7*	9	500	0	15/30	$N(10,2^2)$
8**	8	500	0	15/30	$N(25,5^2)$
9**	8	200	800	0/30	$N(10,2^2)$
10*	9	200	800	0/30	$N(25,5^2)$
11*	9	200	0	0/30	$N(10,2^2)$
12**	8	200	0	0/30	$N(25,5^2)$
13*	9	200	800	15/30	$N(10,2^2)$
14**	8	200	800	15/30	$N(25,5^2)$
15**	8	200	0	15/30	$N(10,2^2)$
16*	9	200	0	15/30	$N(25,5^2)$

Note: A single asterisk indicates that all sequences for this cell were obtained in week 1 of the experiment. A double asterisk indicates that all sequences for this cell were obtained in week 2 of the experiment. The results in both weeks were similar.

jects also drew lots to determine the auditor-manager pairing and to determine the cell parameters.[9] The cell parameters and subject pairs remained constant throughout each sequence. All relevant cell parameters and the auditor's and manager's payoff functions (see table 5) were common knowlege prior to each sequence.

2. *Fraud Commission.* Each game followed the order of events in the model as depicted in figure 1. The manager could decide not to commit fraud and receive 200 francs, or commit fraud and receive either 58 francs if caught or 560 francs if the fraud was undetected. Fraud increased the percentage of errors in the population by 4 percent.
3. *Tests of Transactions (Test 1).* Without observing the manager's decision, the auditor decided whether to spend 30 francs performing tests of transactions. The auditor who chose to test learned the actual percentage of errors in the population, but not whether the errors were intentional.
4. *Tests of Details of Balances (Test 2).* The auditor then decided whether to perform a high or low level of tests of details of balances. The high level cost 240 francs and provided 70 percent assurance that the auditor would detect fraud if it existed. We varied the low level of test 2 to study the effects of changes in minimum required testing. In half the cells of the design, the low level of test 2 provided a 46 percent assurance at a cost of 120 francs. In the remaining cells, the

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[9] We placed numbers of the cells in a hat. Before each sequence, each manager-subject drew a number from the hat without replacement, and each pair played the cell number drawn by the manager-subject of that particular pair. We replenished the hat only when it became empty. The numbered slips of paper were not reused. These procedures were followed to reduce the possibility of carry-over effects on subsequent sequences.

low level implied no expenditure, no testing, and, consequently, no probability of detecting fraud.

5. *Payoff Computation and Review of Sequence and Game Statistics.* Both manager and auditor reviewed a feedback screen, which contained statistics on the present game and averages of all prior games in the sequence. The cumulative statistics included the percentage of (1) frauds committed, (2) frauds detected relative to the number of games in which fraud was committed, (3) the number of times that tests of transactions were performed, and (4) the number of times that tests of details of balances were performed. Current game data included both players' decisions and the results of test 1 (e.g., 11 percent clerical error this game) and test 2.

The manager's and auditor's feedback screens differed only in the computation of cash payoffs. Table 6 reports the possible payoffs. In the base case of no fraud, the auditor received the fee of either 200 or 500 francs, depending on the cell of the design, minus the costs of tests 1 and 2. If the auditor detected fraud, he or she received an additional bonus of 600 francs. Conversely, failure to detect fraud caused the auditor to suffer a penalty of either 800 or 0 francs, depending on the cell of the design.

The conversion rate of francs into dollars was the same for both manager and auditor (1:3,000), was constant across all cells of the design, appeared on both players' feedback screens in all games, and was common knowledge before the first game commenced. The feedback screen also reported the cumulative total of cash earned for the sequence. The experimenters paid the amount earned for the four sequences at the end of the session.

Subject Pool and Training

The subject pool included 44 business students at the undergraduate or MBA level at the University of Wisconsin. Each subject participated in one training session and two experimental sessions, all of which were 2½ hours long. Payoffs for a 2½ hour experimental session ranged from \$6.54 to \$27.10.[10] Of the 44 subjects trained, 39 participated in the experiment.[11]

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[10] Given the model's assumption of economic rationality, any positive payoff should be sufficient for subjects to behave as the model predicts. However, it is necessary experimentally that subjects' economic incentives dominate all conflicting incentives (e.g., physical fatigue, boredom). In most cells of this experiment, the auditor's and manager's cash payoffs could vary by \$.45 and \$.19, respectively, depending on the decisions made and the outcome. However, considering only the present game's compensation underestimates the economic incentives dominating other alternatives. For example, the disutility from the cognitive effort to determine a better strategy is dominated not only by the gains to be reaped from the current game, but also by the rewards of using this strategy in the remaining games of the sequence and in subsequent sequences.

In addition to the cash payoff, several other factors worked to achieve dominance. The computer handled the tedious recordkeeping function, greatly reducing the complexity of the task and the physical effort required. Subjects had only to review the feedback screen and depress one or two keys to register and communicate their decisions. Further, the cat-and-mouse nature of the game had inherent interest and, indeed, the experimenter observed subjects to be interested and motivated.

[11] We trained 44 subjects, anticipating potential absences. Subjects signed up to participate in two experimental sessions. Some subjects were not able to participate on the day for which they signed up either because an odd number of subjects arrived or because the limited number of terminals in the lab were all in use. This explains why five of those trained did not participate in the experiment. In any case, those that did participate did so because they were motivated. The excess subjects were paid \$3.00 for coming and were dismissed. Those dismissed participated in only one session of their two scheduled sessions, whereas most of the subjects participated in two sessions. This resulted in an odd number of subjects (39) in the experiment.

Table 6
Auditor's Possible Cash Payoffs

Audit Fee		Test 1		Test 2			State Outcome					
									Fraud Undetected			
High	*Low*	*High*	*Low*	*High*	*Low=15*	*Low=0*	*No Fraud*	*Fraud Detected*	*High Penalty*	*Low Penalty*	*Total*	*Cash Payoff*
500		(30)		(240)			0				230	.077
500		(30)		(240)				600			830	.277
500		(30)		(240)					(800)		(570)	−.190
500		(30)		(240)						0	230	.077
500		(30)			(120)		0				350	.116
500		(30)			(120)			600			950	.316
500		(30)			(120)				(800)		(450)	−.150
500		(30)			(120)					0	350	.116
500		(30)				0	0				470	.157
500		(30)				0			(800)		(330)	−.110
500		(30)				0				0	470	.157
500			0	(240)			0				260	.087
500			0	(240)				600			860	.287
500			0	(240)					(800)		(540)	−.180
500			0	(240)						0	260	.087
500			0		(120)		0				380	.127
500			0		(120)			600			980	.327
500			0		(120)				(800)		(420)	−.140
500			0		(120)					0	380	.127
500			0			0	0				500	.166
500			0			0			(800)		(300)	−.100
500			0			0				0	500	.167
	200											

Note: In every game, the manager's base pay was 200 francs. If the manager committed fraud, two outcomes were possible. Detection resulted in a penalty of 142 francs (200−142=58), whereas successfully concealed fraud resulted in an additional bonus of 360 francs (200+360=560). In those cells where the auditor's fee was 200 instead of 500, all totals would be 300 less and all the cash payoffs would be $.10 less than those shown above.

During the training session, all subjects read both the auditor's and manager's instructions and participated in two sequences of at least 40 games. These sequences were identical to the actual experiment with two exceptions: (1) subjects were not paid on the basis of performance, and (2) subjects exchanged roles during the second sequence to ensure all players had experience in both roles.

Neutral Terminology

The authors recognize the importance of ethical and psychological factors; however, this study concentrates solely on the effect of economic incentives. The topic of fraud might elicit an emotive response in subjects or awaken ethical compunctions against committing fraud, all of which might work against the assumption of economic rationality and the economic predictions of the model. So the money paid to subjects would more easily dominate noneconomic motivations, we concealed the topic of the study through neutral terminology (Alm et al. 1989; Smith et al. 1987). For example, managers and auditors were referred to as markers and checkers, and intentional and unintentional errors were referred to as red and blue units, respectively.[12]

IV. Empirical Results

Regressions and Contrasts

The data are analyzed from several different perspectives. We graphically depict the summary statistics for each treatment manipulation in figure 2. Regressions serve to indicate the significance and directional effect of the independent variables.[13] An average of a 40-game sequence is the basis of each observation used in the regressions in table 7. Since some of these averages do not aptly describe the data because of trends and nonstationarity, we also examined contrast series,[14] which plot the difference in the response series (e.g., test 1 percentage) between the high and low levels of each independent variable. We then constructed CuSum charts that facilitate the identification of changes or trends over time. The *t*th CuSum in this case is the cumulative sum of the first *t* observations (differences) from a contrast series (see fig. 3). If the differences

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[12] The checker's (auditor's) and marker's (manager's) instructions are available upon request from the authors.

[13] We ran a MANOVA model with all five dependent variables to control for the experiment-wise error rate. Since the multivariate tests of significance for three of the four independent variables of interest were significant (see table 7), providing the univariate (regression) results serves to explain the MANOVA results. The more parsimonious model presented in table 7 eliminates insignificant interaction on the primary variables, fraud commission, and detection. The full and parsimonious models generated similar results.

[14] Let A^+ and A^- be the set of cell numbers in which the level of audit fee is high and low, respectively. Referring to table 5, we see that $A^+ = \{1,2,3,4,5,6,7,8\}$ and $A^- = \{9,10,11,12,13,14,15,16\}$. The contrast series is defined as:

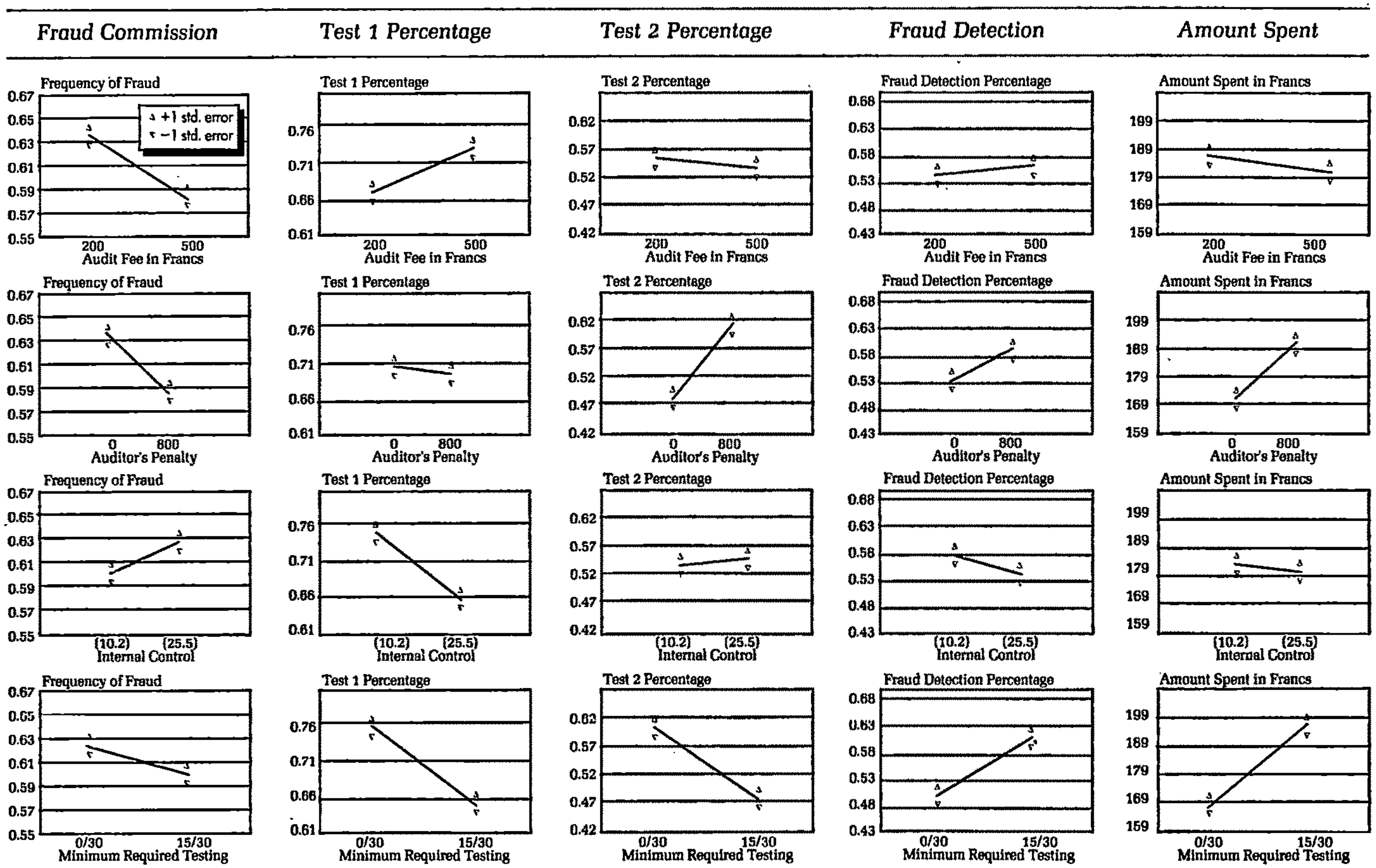
$$d_i = \left(\sum_{h \in A^+} y_{hi} - \sum_{l \in A^-} y_{li} \right) \Big/ 8 \qquad \text{for } i = 1, 2, \ldots, 40,$$

where h = the high level of the independent variable, l = the low level of the independent variable, y represents the average of all observations for a particular cell, and i represents the game number. The tth CuSum S_t is defined as:

$$S_t = \sum_{i=1}^{t} d_i.$$

Figure 2

A Comparison of the Means of the Dependent Variable at Both Levels of the Independent Variable



Note: Means are computed by taking an average of all observations at one level of the independent variable. An observation is defined as the mean of a 40-game sequence.

Table 7
Regression Results

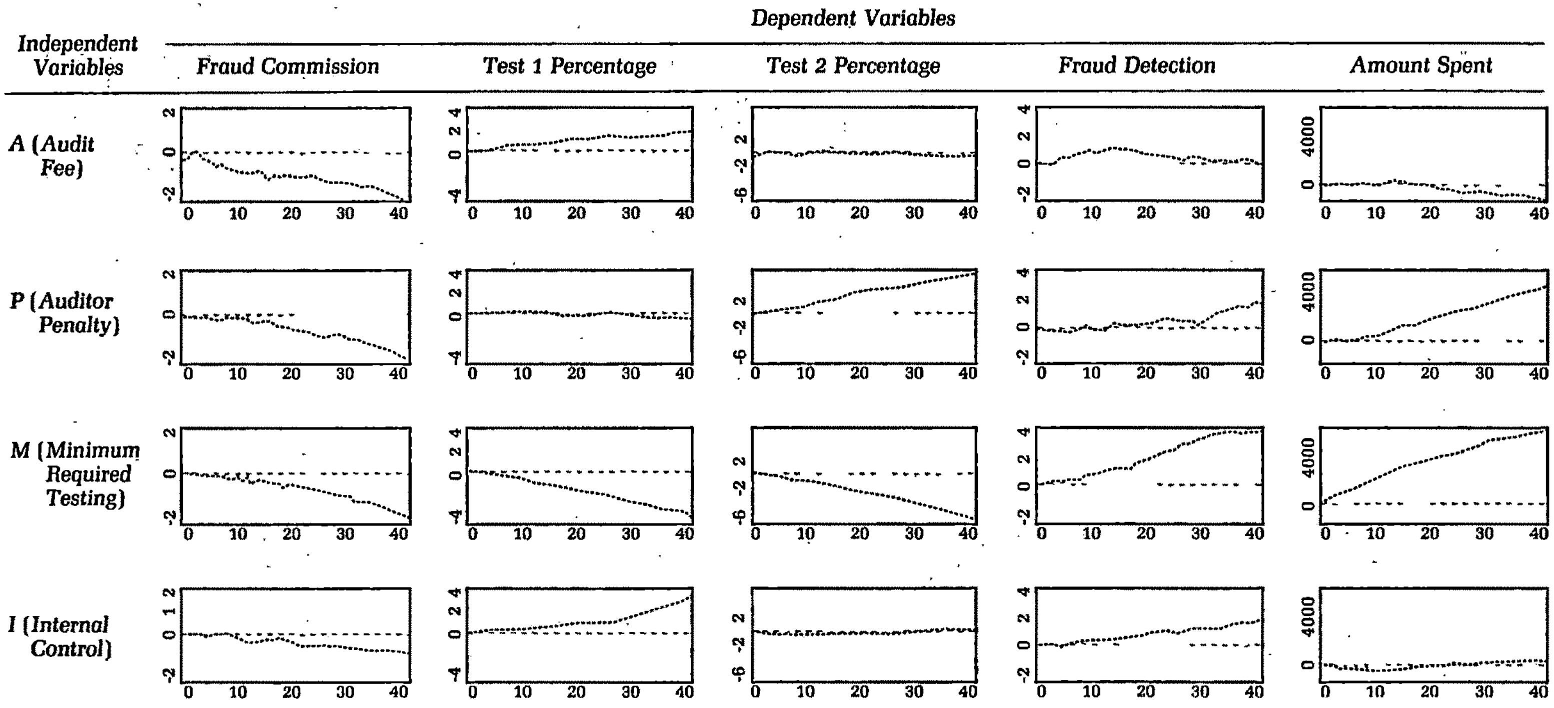
		Dependent Variables				
Effects	*Multivariate Significance*	*Fraud Commission*	*Test 1*	*Test 2*	*Fraud Detection*	*Amount Spent*
Constant		0.611	0.698	0.541	0.565	182.28
		(95.78)	(139.51)	(89.47)	(62.86)	(161.26)
A	(0.086)	−0.028	0.021	−0.007	0.009	−2.25
		(−4.44)	(4.34)	(−1.18)	(1.06)	(−1.99)
P	(0.032)	−0.024	−0.007	0.061	0.032	10.12
		(−3.81)	(−1.24)	(10.22)	(3.61)	(8.95)
M	(0.001)	−0.013	−0.049	−0.064	0.049	14.41
		(−2.15)	(−9.82)	(−10.67)	(5.52)	(12.75)
I	(0.330)	−0.012	0.042	−0.002	0.017	0.59
		(−1.96)	(8.41)	(−0.32)	(1.95)	(0.52)
AP		−0.019	−0.042	0.008	0.015	0.72
		(−2.96)	(−8.51)	(1.45)	(1.75)	(0.64)
AI		−0.024	−0.018	−0.013	0.001	−2.96
		(−3.70)	(−3.72)	(−2.16)	(0.19)	(−2.62)
PI		−0.007	−0.027	−0.033	−0.020	−4.81
		(−1.23)	(−5.55)	(−5.46)	(−2.26)	(−4.25)
API		−0.004	−0.014	−0.009	−0.019	−2.33
		(−0.69)	(−2.83)	(−1.51)	(−2.17)	(−2.06)
PMI		−0.023	−0.017	−0.037	0.003	−5.30
		(−3.68)	(−3.53)	(−6.20)	(0.38)	(−4.69)
APMI	(0.840)	−0.017	−0.042	0.004	0.009	0.03
		(−2.67)	(−8.52)	(0.70)	(1.04)	(0.03)

Note: *A*, *P*, *M*, and *I* denote the four independent variables: audit fee, penalty, minimum required testing, and internal control. The *t*-statistics, enclosed in parentheses, appear below the corresponding coefficient. Use of a one-tailed *t*-test is appropriate when directional predictions exist (see table 3). One-tailed significance at $\alpha=0.1$, 0.05, 0.01, and 0.0005 is 1.30, 1.67, 2.39, and 3.46, respectively. Two-tailed significance at $\alpha=0.1$, 0.05, 0.01, and 0.001 is 1.67, 2.00, 2.66, and 3.46. Insignificant interactions on the primary variables, fraud commission and fraud detection, were deleted. The full and simpler models yielded similar results.

have a mean greater than zero, then the slope of the CuSum is positive and shows an upward trend. Similarly, a downward trend reflects a negative mean. The discussion of the empirical results draws on the information in the regressions in table 7 and in figures 2 and 3.

Previous experimental economics studies of auditing issues have typically used four or fewer independent observations for each cell. Such sample designs limit the experimenter's ability to employ classical statistical tests based on truly independent observations. In contrast, the data set in this study consists of eight or nine independent observations for each cell, which increases the power of our test and our ability to draw statistical inferences.

Figure 3
CuSum Charts



Note: Each of the CuSum charts shows cumulative sums of contrasts (differences of average responses at the high and low levels of the independent variables) for games $t=1,\ldots,40$. A positive (negative) slope of a CuSum indicates that the average response at the high level of the independent variable was consistently greater (less) than at the low level of the independent variable. CuSum charts show not only the effects of factors on responses but also reveal mean changes over time (a potential intrasequence shift in strategy).

Fraud Commission. The coefficients and *t*-statistics for the dependent variable of fraud commission are given in table 7. All the main effects (i.e., *A*, audit fee; P, penalty; *M*, minimum required testing; and I, internal control) and four interactions (*AP*, *AI*, *PMI*, and *APMI*) were significant at $p<0.05$. The negative signs on the main effects suggest that managers committed less fraud with increases in audit fees, auditor's penalties, minimum required testing for fraud, and strength of internal control. The experimental results confirm the analytical predictions shown in table 3, except for penalty and internal control. Conversely, the results did not support the analytical predictions for the variables of minimum required testing[15] and audit fee. However, the result for audit fee did support the prediction advanced by members of the profession that lower audit fees may result in substandard auditing and hence provide managers with an incentive to commit fraud.

The model assumes that all players are risk-neutral and that this is common knowledge. In this multiperiod experiment, subjects have incomplete information in that they do not know each other's true utility functions. For this reason, subjects may attempt to establish a reputation for having a utility function of a particular form. If the Cohen Commission's argument holds, then the managers should anticipate that auditors will be more vigilant in the presence of the higher audit fees, and hence managers should commit less fraud under this regime. In fact, the auditors did test more aggressively during the first 15 games of the sequence when the audit fee was higher, and the managers committed less fraud throughout the entire sequence.

One should interpret the main effect results in light of the significant interactions. The least fraud occurred when *A*, P, *M*, and *I* were at a high level, *A* and P had the same sign (which implies that both were at the high or low level), *A* and *I* had the same sign, and the product *PMI* was positive. This is true when *A*, P, *M*, and *I* are all at the high level.

Tests of Transactions (*Test 1*). The regression results in table 7 indicate that three main effects—*A* (audit fee), *M* (minimum required testing), and *I* (internal control)—were highly significant ($p<0.0005$). These results imply that, as internal control became stronger or audit fees increased, auditors invested more in tests of transactions. The negative coefficient of M suggests that subjects reduced discretionary testing when forced to sample 15 in test 2. This is consistent with the notion that different types of audit evidence can substitute for one another. These results confirm the analytical predictions (see table 3) regarding the effect of *M* and *I* on tests of transactions; the effect of audit fee confirmed the prediction based on our interpretation of the Cohen Commission's argument.

The coefficient of P (penalty) was not significant. However, the CuSum results in figure 3 illustrate that the mean changed from positive in the first nine games to negative in the remaining 31. As auditors decided to purchase test 2 more frequently, evidence bearing on that decision (i.e., test 1) became less valuable. All interactions were significant at $p<0.05$, which suggests that one must consider the specific context when interpreting the main effects results and the comparative static predictions regarding test 1.

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[15] The analytical result that increasing minimum testing standards increases fraud seems counterintuitive and requires some explanation. Two points are worth noting. First, the model's prediction is based on the partial derivative of p with respect to L, evaluated at $L=0$. The derivative was positive, but only marginally so. Second, we framed the difference in testing scenarios ($L=0$, $H=30$; $L=15$, $H=30$) as a forced increase in minimum testing. An alternative frame is that $L=15$ represents a previously unavailable testing option that may be superior to $H=30$ in many cases. It is not that auditors are decreasing the amount of testing desired when $L=15$. Rather, if they desired to test, then they were forced to choose $H=30$ when confronted with the $L=0$, $H=30$ scenario. Empirically, managers defrauded less and auditors tested less than the equilibrium prediction. Consequently, the possibility of overtesting with ($L=0$, $H=30$) is less probable.

Detailed Tests of Balances (Test 2) and Total Amount Spent on Testing. Two strong main effects affecting the purchase of test 2 are shown in table 7, and both confirm the respective analytical predictions (see table 3). The results also are consistent with the analytical prediction that changes in audit fee have no effect. Increases in penalty (P) increased purchases of test 2 at a high level ($p<0.0005$), whereas increases in minimum required testing (M) decreased purchases of test 2 at a high level ($p<0.0005$). As mentioned, auditor-subjects decreased discretionary spending when the minimun testing requirement increased. Despite these decreases in the purchase of both test 1 and the high level of test 2, total audit costs (amount spent) increased ($p<0.0005$) with increases in minimum required testing. Although auditors spent more on testing when their penalty increased, the additional costs were not without benefit, as fraud detection increased ($p<0.0005$) and fraud commission decreased ($p<0.0005$).

Although the main effects for A and I did not achieve significance for test 2, they did affect test 2 through the interactions AI and PI, which were significant ($p<0.05$).

Fraud Detection. For the dependent variable Fraud Detection, three main effects—P (penalty), M (minimum required testing), and I (internal control)— and two interactions, PI and API, were significant at $p<0.05$. The fourth main effect, A (audit fee), was not significant. The results on the main effects confirm the analytical predictions (see table 3).

Since the interactions PI and API have negative signs, more fraud detection occurred when P and I were at different levels and the product of API was negative. Moreover, if P (penalty) was at a high level, then stronger internal control (I) actually decreased fraud detection. One explanation is that stronger internal control stimulates the purchase of test 1 ($p<0.0005$); however, when exposed to a high penalty, auditors may use test 1 to decide when not to purchase test 2.

To summarize, the regression results allow us to draw the following inferences: economic incentives did affect subjects' responses to changes in the level of factors, for most cases in the direction predicted *a priori*. Several interactions are significant, and the existence of these interactions suggest that the impact of a factor can be affected by the situation.

Correlations and Cross-Correlations Among Dependent Variables

We explored the relationship between fraud, testing, and detection by using correlations of both the 40-game means (i.e., aggregate correlations) and the game-by-game data within the 40-game sequence (cross-correlations). The aggregate correlations provide evidence on the relationship between two dependent variables but do not suggest causality. To generate evidence supportive of causality, we use cross-correlations of game-by-game data. The dynamic interaction manifest in game-by-game correlations captures, in part, how the players responded to each other's decisions. Several important questions relate to causality. For example, is fraud deterred by testing and detection or, conversely, encouraged by lack of testing and failure to detect fraud? Also, does the commission of fraud spur more testing? Table 8 displays the cross-correlations among all the dependent variables for each of the four contrast series.

Table 8

Cross-Correlations Between Contrast Series of Different Dependent Variables Using Game-by-Game Data

Correlates $V_{1,t+0}$ (Variable 1 at time t) with $V_{2,t+k}$ (Variable 2 at time $t+k$)

Audit Fee
Significant Lags

$V_{1,t+0}$	$V_{2,t+k}$	$k=$ −3	−2	−1	0	1	2	3
FC	*T1*							−
FC	*T2*		−	−	+			
FC	*FD*		−	−				
FC	*AS*		−		+	−	−	
T1	*T2*				+			
T1	*FD*	+		+	+			
T1	*AS*				+			
T2	*FD*				3		+	
T2	*AS*				4			
FD	*AS*	+			3			

Internal Control
Significant Lags

$V_{1,t+0}$	$V_{2,t+k}$	$k=$ −3	−2	−1	0	1	2	3
FC	*T1*				+	+		
FC	*T2*	−			+			
FC	*FD*				−			+
FC	*AS*	−			+			
T1	*T2*			+				
T1	*FD*						+	
T1	*AS*		+			+		
T2	*FD*			+				
T2	*AS*		+		3		+	
FD	*AS*				2			

Required Testing
Significant Lags

$V_{1,t+0}$	$V_{2,t+k}$	$k=$ −3	−2	−1	0	1	2	3
FC	*T1*			−	+	+		
FC	*T2*	−	+		+	+		
FC	*FD*	−						
FC	*AS*	−	+		+	+		
T1	*T2*			+				
T1	*FD*	−		−		−	+	−2
T1	*AS*	−			+	+		
T2	*FD*				+	−		
T2	*AS*	+		4				
FD	*AS*			−		+		

Auditor Penalty
Significant Lags

$V_{1,t+0}$	$V_{2,t+k}$	$k=$ −3	−2	−1	0	1	2	3
FC	*T1*							
FC	*T2*		−		+			
FC	*FD*	−						+
FC	*AS*	−		+				
T1	*T2*	−	−	−	−	−	−	−
T1	*FD*	−	−	−	−	−	−	−
T1	*AS*			−				
T2	*FD*			+	+	+	+	
T2	*AS*				3			
FD	*AS*			2	+			

Note: One-tailed test is significant at $\alpha \doteq 0.05$ if the correlation, $\rho(V_{1,t}, V_{2,t+k})$, is 0.195 or greater. A plus (minus) sign indicates a correlation between positive (negative) 0.2 and 0.4; 2 indicates a positive correlation between 0.4 and 0.6; −2 indicates a negative correlation between −0.4 and −0.6; and so on.

FC = the percentage of games in which fraud was committed;
T1 and *T2* = percentage of games in which test 1 and test 2 were performed, respectively;
FD = the number of frauds detected divided by number of frauds committed; and
AS = the total amount spent on testing.

Example: For the audit fee response, a negative correlation is reported at lag $k=-2$ between fraud commission and fraud detection $(-0.2 > \rho(FC_t, FD_{t+k}) > -0.4)$. This implies that if the auditor detects fraud in games 1,2,3,. . .,38, fraud will be less likely to be committed two games hence (i.e., games 3,4,5,. . .40).

The results reported in table 8 summarize correlations that are significant at $p<0.05$. The first four correlations (between fraud commission and test 1, test 2, fraud detection, and amount spent)[16] are generally negative for negative lags, but positive for

[16] The positive relationships between test 2 and detection, test 2 and amount spent, and detection and amount spent are to be expected. Test 2 provides a 71 percent probability of detecting fraud, given it exists, and costs 240 francs, whereas test 1 costs only 30.

nonnegative lags. These results support affirmative answers to the questions asked above. The inverse correlation between testing and detection at times −3, −2, −1, and fraud at time zero supports the contention that (1) testing and detection deter fraud and (2) lack of testing or failure to detect encourages fraud. The positive correlation for most nonnegative lags suggests that fraud spurs the auditor to test and to detect fraud more often.

Consistent with the notion that subjects did not perform test 2 randomly, we found positive cross-correlations between fraud commission and test 2 and between test 2 and detection at lag 0. One explanation is that each auditor referred to the summary of the manager's decisions during prior games of the 40-game series. Another explanation is that subjects determined when to purchase test 2 by properly evaluating the signal obtained from test 1.[17]

Regarding the minimum required testing variable, we make two observations. First, the aggregate correlation[18] between fraud detection and amount spent is lower (0.387 vs. 0.552) when auditors are required to purchase a minimum sample size of 15 for test 2. Hence, with mandated testing, amount spent and detection increased (see table 7) but the marginal effectiveness of money spent on testing decreased. Second, in cells with mandated testing, the aggregate correlations (0.184 vs. −0.373) and the cross-correlations (see table 8) between tests 1 and 2 are higher. The regression analysis indicates auditors decreased discretionary testing (high level of test 2) when required to sample. One justification for cross-correlations between tests 1 and 2 may be that a convincing signal from test 1 overcame subjects' reluctance to purchase a high level of test 2. The negative aggregate correlation (−0.373) in other cells ($L=0$) may result from a different use of test 1. Desiring information from test 2 but faced with a choice of $L=0$ or $H=30$, subjects used test 1 to decide when *not* to purchase a high level of test 2.

Regarding the internal control variable, we make two observations. First, when internal control is strong, the aggregate correlation between tests 1 and 2 is higher (0.215 vs. −0.154) and auditors perform test 1 more often. This is consistent with the idea that if internal control is strong and fraud exists, then tests of transactions (test 1) will lead to more detailed tests of balances (test 2). However, if internal control is weak and fraud exists, then test 1 is less likely to lead to use of test 2. Second, higher aggregate correlations exist between fraud commission and test 2 (0.416 vs. 0.121) and between commission and amount spent (0.354 vs. 0.044) when internal control is strong. This may reflect the auditors' ability to time the purchase of test 2 more effectively. An alternative explanation is that aggressive audit testing deterred managers less often when internal control was weak.

A salient result from cross-correlations of the contrast series for penalty is that subjects purchasing test 1 tended to purchase test 2 less often. Consequently, they detected fraud less often. One implication of this scenario is that subjects who relied on compliance testing to reduce the extent of substantive tests suffered in a high-penalty environment.

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[17] As shown in table 7, auditors purchased more of test 1 with strong internal control ($p<0.0005$). Although auditors did not spend more on test 2 (i.e., the sign of the coefficient for internal control is negative), they detected fraud more frequently ($p<0.05$). This suggests that auditors did rely on test 1 to determine their timing of test 2.

[18] A table of all aggregate correlations is available from the authors upon request.

V. Conclusion

The objective of this study was to gain a better understanding of the strategic interaction between a manager who can commit fraud and an auditor who can test for fraud. We strive to develop theory through two research methods, rigorous game-theoretic analysis and economic experimentation, and we designed each part of the project with the other part in mind. Corroboration between the findings from analysis and experimentation lends credence to the validity of findings.

Most of the statistically significant responses to different treatment levels of the independent variables were directionally consistent with the model's predictions. An increase in the auditor's penalty decreased fraud, increased detailed tests of balances, and increased fraud detection.

When forced to increase the minimum amount of testing for fraud, auditors decreased discretionary testing yet still spent more on testing overall. The increased spending increased fraud detection and decreased fraud commission. However, the marginal effectiveness of money spent on testing (i.e., efficiency) decreased when auditors were forced to meet higher minimum standards in all games.

The strength of the internal control structure played an important role in fraud detection and prevention. When internal control was strong, auditors performed more tests of transactions, did not perform more tests for fraud, yet detected fraud more frequently. In addition, managers committed fraud less frequently. A stronger internal control structure also promoted higher correlations (1) between the purchase of tests of transactions and tests for fraud and (2) between fraud commission and tests for fraud.

An increase in the auditor's fee resulted in less fraud and in more tests of transactions but in less spent on testing overall. The CuSum graphs revealed that auditors spent more on testing and detected more fraud in early games but did the opposite in later games of the 40-game series. This example of multiperiod gaming highlights the need to supplement single-period analysis, as well as statistical analysis based only on the mean of the series. These results do not support the analytical finding that the audit fee level is irrelevant.

The correlation and cross-correlation analyses supported four conclusions: (1) subjects inferred when to perform detailed tests of balances (test 2) by purposefully evaluating the evidence obtained from tests of transactions (test 1), (2) testing and detection deterred fraud, (3) lack of testing or failure to detect encouraged fraud, and (4) the incidence of fraud resulted in greater testing and detection in future games.

It should be stressed that our anlaysis and experiment were sufficiently general to fit both types of irregularities, fraud and defalcations, yet not so specific as to exclude either one. Hence, any generalizations should pertain to the detection of irregularities rather than to specific aspects of management fraud. Modeling the unique ways in which management fraud is perpetrated and discovered, as opposed to other types of irregularities, remains for future research. Also, we focused solely on the effect of economic incentives and therefore leave for further study the effects of ethical or psychological factors on fraud commission and detection.

Appendix

Statement of Propositions

Proposition 1. For a given level of internal control and a given prior probability p that the manager chooses $\hat{t}$ (i.e., commits fraud), the auditor's optimal decisions are as follows:

1. If the auditor performs test 1 and therefore learns the percentage of errors, y (fig. 1, node 1), then the auditor's optimal sample size for test 2 is:

$$a_2^*(y)=\begin{cases} L & \text{if } y<K, \\ H & \text{if } y>K, \end{cases} \tag{A1}$$

where $K=(\sigma^2/\hat{t})\ell n[Z/(1-Z)]+\mu+\hat{t}/2+(\sigma^3/\hat{t})\ell n[(1-p)/p]$ and $Z=c_2(H-L)/[(A_g+A_l)(Q_1-Q_2)]$

2. If the auditor does not perform test 1 (fig. 1, node 2), then the auditor's optimal sample size for test 2 is:

$$a_2^*(\varnothing)=\begin{cases} L & \text{if } p<Z, \\ H & \text{if } p>Z, \end{cases} \tag{A2}$$

where Z is defined as in part 1.

3. Two cases exist at node 3, figure 1, where the auditor decides whether to perform test 1. Let Φ_f=Probability ($y<K$|fraud exists) and Φ_o=Probability ($y<K$|fraud does not exist).

Suppose $p<Z$. The auditor's optimal strategy at node 3 is $a_1^*=0$ if,

$$\frac{c_1w+c_2(H-L)(1-\Phi_0)(1-p)}{[(A_g+A_l)(Q_1-Q_2)-c_2(H-L)]p}>1-\Phi_f, \tag{A3}$$

and $a_1^*=w$ otherwise. In this case the auditor's optimal strategy is either strategy 1 [$a_1=0$, $a_2^*(\varnothing)=L$], or strategy 2 [$a_1=w, a_2^*(y)$].

Suppose $p>Z$. The auditor's optimal stategy at node 3 is $a_1^*=0$ if,

$$\frac{c_2(H-L)\Phi_0(1-p)-c_1w}{[(A_g+A_l)(Q_1-Q_2)-c_2(H-L)]p}<\Phi_f, \tag{A4}$$

and $a_1^*=w$ otherwise. In this case, the auditor's optimal strategy is either strategy 3 [$a_1=0$, $a_2^*(\varnothing)=H$] or strategy 2 [$a_1=w, a_2^*(y)$].

Proposition 2. The manager's optimal choice p^* at the beginning of the game (fig. 1, node 4) depends on the auditor's optimal strategy, as follows:

1. If the auditor employs strategy 1, [$a_1=0$, $a_2^*(\varnothing)=L$], the manager's optimal choice is $p^*=1$ if,

$$M_gQ_1-M_l(1-Q_1)>0,$$

and $p^*=0$ otherwise.

2. If the auditor employs strategy 3, [$a_1=0$, $a_2^*(\varnothing)=H$], the manager's optimal choice is $p^*=1$ if,

$$D\equiv M_gQ_2-M_l(1-Q_2)>0,$$

and $p^*=0$ otherwise.

3. If the auditor employs strategy 2 [$a_1=w$, $a_2^*(y)$], the manager's optimal choice is characterized by the following first-order condition:

$$\Phi_f[K(p)]+\frac{D}{(M_g+M_l)(Q_1-Q_2)}+\frac{\sigma}{\hat{t}(p-1)\sqrt{2\pi}}\exp\left(\frac{-[K(p)-(\mu+\hat{t})]^2}{2\sigma^2}\right)=0, \tag{A5}$$

where D is as defined in part 2 and $\Phi_f[K(p)]$ emphasizes the dependence of K on p.

Proposition 3. The Nash equilibria (auditor strategy, manager's probability of committing fraud) of the game are as follows:

1. (Strategy 1, $p=0$) is a Nash equilibrium if equation (A3) in Proposition 1 holds and,

$$M_gQ_1-M_l(1-Q_1)\leq 0.$$

2. (Strategy 3, $p=1$) is a Nash equilibrium if equation (A4) in Proposition 1 holds and,

$$M_gQ_2-M_l(1-Q_2)>0.$$

3. (Strategy 2, p^*), where p^* satisfies the first-order condition in equation (A5) in Proposition 2.

Proof of Propositions

Proof of Proposition 1: Let P=posterior probability that the manager committed fraud, i.e., $P=\Pr(\text{fraud}\,|\,y)$,

$$=\frac{f(y\,|\,t=\hat{t})\Pr(t=\hat{t})}{f(y\,|\,t=\hat{t})\Pr(t=\hat{t})+f(y\,|\,t=0)\Pr(t=0)},$$

where $\Pr(t=\hat{t})=p$, $\Pr(t=0)=1-p$, and $f(\cdot)$ is a normal density with mean $\mu+t$ and variance σ^2. Because the auditor is assumed to be risk-neutral, the auditor's decisions are unaffected by the audit fee

Node 1: $a_1=w$, so the auditor observes y, the actual percentage of errors in the population. Compare the following expected returns for the auditor:

$$a_1=w \text{ and } a_2=L\text{: } A_g(1-Q_1)P-A_lQ_1P-c_2L; \tag{A6}$$

$$a_1=w \text{ and } a_2=H\text{: } A_g(1-Q_2)P-A_lQ_2P-c_2H. \tag{A7}$$

Equation (A1)<equation (A2) if,

$$P>\frac{c_2(H-L)}{(A_g+A_l)(Q_1-Q_2)}\equiv Z. \tag{A8}$$

Substituting $\Pr(\text{fraud}\,|\,y)$

$$=\frac{1}{\sqrt{2\pi}\sigma}\exp\{-[y-(\mu+t)]^2/2\sigma^2\},$$

into the expression for P in equation (A8) and simplifying shows that equation (A6)>equation (A7) if $y<K$. This establishes equation (A1).

Node 2: $a_1=0$. The comparison is the same as for node 1 and results in equation (A8) with P replaced by p. This establishes equation (A2).

Node 3: The use of backward induction and knowledge of the optimal strategies at nodes 1 and 2 permit us to compare only the auditor's expected returns with [$a_1=0$ and $a_2^*(\phi)$] and [$a_1=w$ and $a_2^*(y)$].

1. Suppose $p<Z$. If $a_1=0$, then $a_2^*=L$. Thus, compare the following expected returns to the auditor:

$$a_1=0 \text{ and } a_2^*(\phi)=L\text{: } A_g(1-Q_1)p-A_lQ_1p-c_2L, \text{ and} \tag{A9}$$

$$\begin{aligned} a_1=w \text{ and } a_2^*(y)\text{: } &\int_{-\infty}^{K} A_g(1-Q_1)Pg(y)dy \\ &+\int_{-\infty}^{K} -A_lQ_1Pg(y)dy+\int_{K}^{\infty} A_g(1-Q_2)Pg(y)dy \\ &+\int_{K}^{\infty} -A_lQ_2Pg(y)dy-c_2(H-L)[\Pr(y>K\,|\,t=0)(1-p) \\ &+\Pr(y>K\,|\,t=\hat{t})p]-c_1w-c_2L, \end{aligned} \tag{A10}$$

where $g(y)=f(y\,|\,t=\hat{t})\Pr(t=\hat{t})+f(y\,|\,t=0)\Pr(t=0)$. Letting $\phi_t=\Pr(y\leq K\,|\,t=\hat{t})$, and $\phi_o=\Pr(y\leq K\,|\,t=0)$ and simplifying the inequality (A9)<(A10) establishes equation (A3), assuming,

$$[(A_g+A_l)(Q_1-Q_2)-c_2(H-L)]p>0. \tag{A11}$$

2. Suppose $p>Z$. If $a_1=0$, then $a_2^*=H$. Thus, compare the following expected returns to the auditor:

$$a_1=0 \text{ and } a_2^*(\phi)=H\text{: } A_g(1-Q_2)p-A_lQ_2p-c_2H \tag{A12}$$

$a_1=w$ and $a_2^*(y)$: as in equation (A10). Simplifying the inequality (A12)< (A10) establishes equation (A4), assuming equation (A11) holds.

Proof of Proposition 2: Note that because the manager is assumed to be risk-neutral, the manager's decisions are unaffected by the fee received.

1. If the auditor employs strategy 1 ($a_1=0$, $a_2=L$), the manager's problem is:

$$\max_{p} \quad (1-p)(0)+p[M_gQ_1-M_l(1-Q_1)].$$

Since the objective function is linear in p, the manager's optimal choice is:

$$p^*=\begin{cases}1 & \text{if } M_gQ_1-M_l(1-Q_1)>0,\\ 0 & \text{if } M_gQ_1-M_l(1-Q_1)<0.\end{cases}$$

2. If the auditor employs strategy 3 ($a_1=0$, $a_2=H$), the manager's problem is:

$$\max_{p} \quad (1-p)(0)+p[M_gQ_2-M_l(1-Q_2)], \text{ and}$$

the manager's optimal choice is:

$$p^*=\begin{cases}1 & \text{if } (1-Q_2)(-M_l)+Q_2M_g>0,\\ 0 & \text{if } (1-Q_2)(-M_l)+Q_2M_g<0.\end{cases}$$

3. If the auditor employs strategy 2 [$a_1=w$, $a_2^*(y)$], the manager's problem is:

$$\max_{p} \quad (1-p)(0)+p\{\phi_t[M_gQ_1-M_l(1-Q_1)]+(1-\phi_t)[M_gQ_2-M_l(1-Q_2)]\}.$$

Equivalently, the manager's problem is:

$$\max_{p} \quad p\{M_gQ_2-M_l(1-Q_2)+\phi_t[K(p)][(M_g+M_l)(Q_1-Q_2)]\},$$

where $\phi_t[K(p)]$ indicates that ϕ_t is the value of the cumulative distribution function of $N(\mu+\hat{t},\sigma^2)$ evaluated at $K(p)$. The first-order condition is:

$$\phi_t[K(p)]+[M_gQ_2-M_l(1-Q_2)]/[M_g+M_l](Q_1-Q_2)$$
$$+\frac{\sigma}{\hat{t}(p-1)(\sqrt{2\pi})}\exp\left\{\frac{-[K(p)-(\mu+\hat{t})]^2}{2\sigma^2}\right\}=0.$$

Proof of Proposition 3: The definition of K requires $0<Z<1$. We list below the possible equilibria. In Proposition 1 where $p<Z$, suppose inequality (A3) holds. Then the auditor's optimal strategy is strategy 1 (no test 1, low test 2). If $M_gQ_1-M_l(1-Q_1)\leq 0$, then by Proposition 2, the manager's optimal choice is $p^*=0$. Because $0<Z$, it follows that $p^*<Z$, and the auditor's optimal response to $p^*=0$ is strategy 1. Hence, (strategy 1, $p^*=0$) is an equilibrium if inequality (A3) holds and $M_gQ_1-M_l(1-Q_1)\leq 0$. If inequality (A3) does *not* hold, but $p^*<Z$ satisfies the first-order condition in equation (A5) of Proposition 2, then (strategy 2, p^*) is an equilibrium.

In Proposition 1, where $p>Z$, suppose inequality (A4) holds. Then the auditor's optimal strategy is strategy 3 (no test 1, high test 2). If $M_gQ_2-M_l(1-Q_2)>0$, then by Proposition 2, the manager's optimal choice is $p^*=1$. Because $Z<1$, it follows that $Z<p^*$, and the auditor's optimal response to $p^*=1$ is strategy 3. Hence, (strategy 3, $p^*=1$) is an equilibrium if inequality (A4) holds and $M_gQ_2-M_l(1-Q_2)>0$. If inequality (A4) does not hold but $p^*>Z$ satisfies the first-order condition in equation (A5) of Proposition 2, then (strategy 2, p^*) is an equilibrium.

Proof of Comparative Statics

Proof Related to Footnote 4:

$$\frac{\partial K}{\partial Z}=\frac{\sigma^2}{\hat{t}Z(1-Z)}>0 \quad \text{if } 0<Z<1 \text{ and} \tag{A13}$$

$$\frac{\partial Z}{\partial A_l}=\frac{c_2(L-H)}{(Q_1-Q_2)(A_g+A_l)^2}<0.$$

Therefore,

$$\frac{\partial K}{\partial A_l}=\frac{\partial K}{\partial Z}\frac{\partial Z}{\partial A_l}<0 \quad \text{if } 0<Z<1.$$

The unconditional probability of fraud detection, given fraud exists and strategy 2 is used, is:

$$B=1-\int_{(1-\hat{t})}^{a_2(y)} f(y|t=\hat{t})dy$$

$$=1-\left((1-\hat{t})^L\Phi_t[K(p)]+(1-\hat{t})^H\{1-\phi_t[K(p)]\}\right).$$

$$\frac{\partial B}{\partial A_l}=\phi_t'[K(p)]\frac{\partial K}{\partial A_l}[(1-\hat{t})^H-(1-\hat{t})^L]>0 \qquad \text{if } 0<Z<1.$$

Proof Related to Footnote 5:

$$\frac{\partial Z}{\partial L}=\frac{c_2}{A_g+A_l}\left[\frac{(Q_2-Q_1)+(L-H)(1-\hat{t})^L \ell n(1-\hat{t})}{(Q_1-Q_2)^2}\right]>0,$$

for the parameters in this study.

$$\frac{\partial K}{\partial L}=\frac{\partial K}{\partial Z}\frac{\partial Z}{\partial L}>0, \qquad \text{(see eq. [A13])}.$$

Proof Related to Footnote 6: The probability of fraud detection, given fraud exists, with strategy 1 is $1-(1-\hat{t})^L$. Its derivative with respect to L is $-(1-\hat{t})^L \ell n((1-\hat{t})>0$ if $0<\hat{t}<1$. The probability of fraud detection, given fraud exists, with strategy 3 is $1-(1-\hat{t})^H$, which is unaffected by changes in L. The derivative with respect to L (evaluated at $L=0$) of B, the unconditional probability of fraud detection, given fraud exists and using strategy 2, was evaluated numerically for all values of p for which strategy 2 is optimal. In all such cases, the derivative was positive.

Proof Related to Footnote 7:

$$\frac{\partial K}{\partial \mu}=1;$$

if p is fixed,

$$\frac{\partial B}{\partial \mu}=\phi_t'[K(p)]\frac{\partial K}{\partial \mu}[(1-\hat{t})^H-(1-\hat{t})^L]<0.$$

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The Effect of Experience on the Auditor's Organization and Amount of Knowledge

Richard M. Tubbs
University of Iowa

SYNOPSIS AND INTRODUCTION: Research (see Wright 1988 and Bedard 1989 for reviews) has examined how experience affects the auditor's ability to perform audit tasks successfully. A plausible explanation (see, e.g., Schmidt et al. 1986) for the failure to obtain a significant positive relationship between experience and performance with regularity is that these constructs are indirectly related (for other reasons see Bonner 1990). Few studies have attempted to explicate this indirect relationship by examining the knowledge and skills that develop with audit experience and may lead to improved task performance (cf. Alba and Hutchinson 1987).[1]

The current study focuses on the manner in which experience affects knowledge structure for several reasons. First, identification of "systematic differences in content and structure of (domain-specific) knowledge . . . can be used to facilitate investigating the relationship [between experience and performance]" (Davis and Solomon 1989, 160). For example, when systematic differences are identified, the relationship between these differences and expert performance can be examined empirically. Second, a more refined knowledge structure is considered by many (e.g., Chi et al. 1982) to have a significant influence on skilled performance. Substantiating this point, Schmidt et al. (1986) found that job knowledge was the strongest determinant of job performance (and that experience was the strongest determinant of job knowledge). In accounting, many researchers

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[1] In this framework, experience is considered a necessary but not a sufficient prerequisite for developing expert performance.

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(e.g., Frederick and Libby 1986; Biggs et al. 1988) have attributed differences in behavior to differences in knowledge, but only Bonner and Lewis (1990) and Bonner et al. (1992) have reported results consistent with this relationship.

This article investigates the nature of changes in the auditor's knowledge about errors and irregularities as experience is acquired.[2] Knowledge of errors is examined for three reasons. First, identification of errors is important to auditors; Statement on Auditing Standards (SAS) No. 53 (AICPA 1988a) specifically makes the auditor responsible for detecting errors. Second, understanding the characteristics of errors and their interaction is important when designing and performing appropriate audit procedures and evaluating the results of those procedures (AICPA 1988a, 3). Since such an understanding appears to be complex, the auditor's knowledge of errors is likely to be a meaningful area for studying the effects of experience. Third, sparse research (Libby 1985; Libby and Frederick 1990) has examined the structure of auditors' knowledge of errors.

Identifying differences in knowledge between inexperienced and experienced auditors is of potential practical benefit for the training of auditors (cf. Brown and Stanners 1983). Furthermore, identification of knowledge differences can assist in more effective assignment of auditors to tasks for which they have the appropriate level of knowledge. Finally, the development of decision aids and expert systems in auditing (see Brown and Murphy 1990; Messier and Hansen 1987) can be improved.

Earlier research suggests that, as auditors gain experience: (1) they know more errors, (2) they have more accurate error knowledge, (3) they know more atypical errors, and (4) the causally-related features of errors (where the errors occurred and the internal control objectives violated) become relatively more salient.

Ninety-five subjects at four levels of experience performed two tasks. In task 1, subjects were given 15 minutes to list as many errors as possible that would occur in the sales-receivables-cash receipts cycle of a typical wholesaling or manufacturing company. This task was expected to facilitate examination of the relationship between experience and the quantity, quality, and typicality of knowledge of errors in an unobtrusive manner. Task 2, a conditional prediction task, was employed to produce evidence on the extent to which certain causally-related features of errors become relatively more salient with experience.

Consistent with previous audit research, subjects with greater auditing experience recalled more errors and fewer incorrect items. In addition, subjects with greater auditing experience recalled more atypical errors. Two features of errors that are related to causal explanation, the violated internal control objective and the department in which the error occurred, were found to be salient. However, only the violated internal control objective appeared to increase in salience with experience.

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[2] For the remainder of the article, the term "errors" will be used to represent "errors and irregularities."

Key Words: *Auditing, Experience, Knowledge, Memory.*

Data Availability: *Data used in this study are available from the author upon request.*

THE remainder of this article is organized into four sections. The next section presents the hypotheses to be investigated and the previous literature upon which the hypotheses are based. The second section explains the methods employed to test the hypotheses, and the third section presents the results of the experiments. Finally, the fourth section contains a discussion of the results, possible limitations of the study, and some areas for future research.

I. Formulation of Hypotheses

Importance of Errors in the Audit Process

During an audit, the auditor must rely on error knowledge. For the purposes of this study, errors will be defined as "any departure from the truth in the financial statements or accounting records or any deviation from established and duly authorized and established company policies" (Mautz and Sharaf 1961, 118).[3] Of particular importance is the discovery of an error during the performance of either tests of controls or substantive testing. SAS No. 53 states:

> ... performance of auditing procedures during the audit may result in the detection of conditions or circumstances that should cause the auditor to consider whether material misstatements exist. If a condition or circumstance differs adversely from the auditor's expectation, the auditor needs to consider the reason for such a difference.... When such conditions or circumstances exist, the planned scope of audit procedures should be reconsidered (AICPA 1988a, 9–10).

Thus, SAS No. 53 assumes that the auditor who discovers an error possesses sufficient knowledge about the potential sources and effects of the error to proceed appropriately. Nevertheless, examination of a number of audit manuals provided only very general guidance about how auditors should proceed when errors are found. One aspect of the present study is to investigate whether auditors with different levels of experience possess differential knowledge of errors, which would, in turn, affect their capacity to reconsider the planned scope of audit procedures.

Changes in Knowledge with Experience

Many aspects of an auditor's knowlege about errors are likely to develop with experience.[4] The knowledge of an auditing student or a novice auditor is necessarily confined to information gained from textbooks and, perhaps, training sessions. Further development of knowledge of errors is likely to be a function of specific audit experiences, discussion of audits with colleagues, supervision and review of work by superiors, case materials used in training programs, the following of audit plans, and the use of audit guides. Advanced-level activities such as the supervision of subordinates and designing actual audit plans are likely to reinforce and, perhaps, enhance error knowledge.

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[3] This definition is broader than that presented in SAS No. 53 (AICPA 1988a), but it is consistent with the list of errors identified by reviewing various auditing textbooks and audit manuals, and with the responses of the subjects in this study to task 1 (see table 1).

[4] All aspects of knowledge about errors may not develop with experience in a typical audit environment. For instance, Ashton (1991) found that auditors' base rate frequency knowledge for financial statement errors is not very accurate and that this knowledge does not become more accurate with experience (Libby 1985 and Libby and Frederick 1990 report conflicting results, however). It may be that this specific knowledge about errors is particularly dependent upon direct experience. In fact, Ashton attributes her findings to the fact that auditors' direct exposure to financial statement errors is limited.

In precisely what manner, then, does experience affect the auditor's knowledge of errors? Research in psychology (see, e.g., Hayes-Roth and Hayes-Roth 1975; Hutchinson 1983; Murphy and Wright 1984) has demonstrated that a person with more experience in a substantive area has more items stored in memory.[5] Therefore, as auditing experience is gained, the number of errors known by the auditor is expected to increase. At the same time, it becomes easier to distinguish items that belong to different categories. Weber and Crocker (1983) have shown that increased experience results in a more accurate and more complicated category structure. Therefore, the auditor's concept of errors is likely to become more defined and the ability to determine whether certain errors occur in a particular transaction cycle is likely to improve as experience increases. Employing a hypothesis-generation task, Libby and Frederick (1990) report results that are consistent with these speculations.

In addition, evidence exists that the most typical members of a category[6] are learned first and are more frequently recalled later (Mervis and Pani 1980; Mervis and Rosch 1981; Nelson and Nelson 1978). As auditing experience increases, more atypical errors are expected to be learned. The following three hypotheses are, therefore, proposed:

H1: The number of different types of errors known by the auditor increases with experience.
H2: The accuracy of the auditor's error knowledge increases with experience.
H3: The auditor's knowlege of atypical errors increases with experience.

Other changes in the auditor's knowledge base regarding errors are also likely to occur with experience. Murphy and Medin (1985) maintain that causal relationships become more noticed or more salient in the cognitive structure as experience increases. Support for the idea that, with experience, memory contains more causal relations among known items comes from both developmental and cognitive psychology. Studies in developmental psychology have demonstrated that young children's knowledge is organized along a functional or perceptual dimension, while older children's knowledge is organized along a semantic or conceptual dimension (see, e.g., Howard and Howard 1977; Melkman et al. 1981). Chi and Ceci (1987) argue that these differences in organization are a function of the subject's experience within the domain rather than being a function of the subject's age.

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[5] This research does not address the exact form of the relationship between experience and the number of members of a category in memory other than that the slope of the function is positive. Research from learning psychology (see, e.g., Bower and Hilgard 1981), however, would also suggest that for many categories this function is negatively accelerated and approaches a horizontal asymptote (i.e., strictly concave).

[6] Typicality is the degree to which an object is representative of a category. The typicality of a category member is considered to be a function of how frequently the item is "seen, talked about, or interacted with . . ." (Malt and Smith 1982, 69).

In cognitive psychology, a number of studies have demonstrated differences between "novices" and "experts" in the organization of memory (see, e.g., Adelson 1981; Chase and Simon 1973; Chi et al. 1981; Hutchinson 1983; Schoenfeld and Herrmann 1982).[7] Most of these studies suggest that a person shifts from a "surface" structure to a "deep" or "abstract" structure as she or he gains experience and expertise. Deep structure may involve underlying principles (see, e.g., Chi et al. 1981) or underlying ingredients (Hutchinson 1983). Voss et al. (1983) suggest that as learning within a domain increases, individuals construct causal relationships among concepts and develop strategies or procedures for solving different problems. Chi et al. (1982) support this suggestion by demonstrating that "experts" possess more procedural knowledge and more knowlege about the conditions under which certain procedures should be applied.

Although the professional accounting literature suggests that errors possess many features (AICPA 1988a; Mautz and Sharaf 1961) and that the auditor probably becomes more aware of these features as experience is gained, the psychological literature suggests that the features related to causal explanations should become relatively more salient as experience increases. Which features are causally related, however, can vary from situation to situation. Hayes-Roth and Hayes-Roth (1975) support this idea when they indicate that network configurations in memory are flexible, depending upon the individual's retrieval demands. One feature that is likely to be related to causal reasoning when an error is discovered is the source of the error (AICPA 1987, 10). The source of an error could be the individual perpetrator or the department in which the error occurred. Because the duties assigned to specific personnel vary across companies, the "department" was examined in this study. The discovery of an error that occurred in a specific department should lead to a search for other possible errors in the same department.

A second feature that is likely to be related to causal reasoning when an error is discovered is the control procedure necessary to prevent or detect the error. The discovery of an error that violated a specific control procedure should lead to a search for other potential errors that could occur if that control were not in place. The link between controls and potential misstatements is emphasized in SAS No. 55 (AICPA 1988b). Because there can be an almost one-to-one correspondence between errors and internal control procedures, a more general category, internal control objective, was examined in this study.[8] The preceding discussion leads to the following two additional hypotheses:

H4: The control objective violated when an error occurs is a feature that becomes relatively more salient to the auditor with experience.

H5: The department in which an error occurs is a feature that becomes relatively more salient to the auditor with experience.

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[7] In these studies, the classification of expert appears to be primarily based on experience as opposed to performance. Typically, the experts were faculty or graduate students, while the novices were undergraduate students. An exception is the Chase and Simon (1973) study in which the expert was a master chess player, a classification based on performance.

[8] Control objectives have been employed in prior research (Frederick 1991) as categories around which specific internal controls are organized.

II. Method

Subjects included 72 auditors from ten offices of five different Big Eight firms located in north central Florida. Firms were requested to provide equal numbers of juniors, seniors, and managers with experience in the audits of manufacturing and/or wholesaling companies. This resulted in a sample of 29 juniors, 21 seniors, and 22 managers.[9] In addition, 23 students enrolled in an introductory auditing class participated. These subjects had just completed a study of the sales, receivables, and cash receipts cycle. Median years of auditing experience for the subjects were: students 0; juniors 1; seniors 3; and managers 6.3.

The two tasks were administered to auditors that met in small groups at their offices and to the students at the University of Florida. The researcher was present during all administrations of the experiment. Subjects were assured beforehand that their identities and that of their firms would not be disclosed, and the importance of independent work was stressed. After completing the experimental tasks, demographic information was collected from the subjects by questionnaire. The combined tasks took approximately 45 minutes to complete.

Task 1—Unconstrained Free Recall

Task 1 was an unconstrained free recall task to test hypotheses 1, 2, and 3. This task has been employed only once to study the effects of experience (Hutchinson 1983), but has been used frequently in the study of memory (see, e.g., Bousfield and Barclay 1950; Bousfield and Sedgewick 1944; Gruenewald and Lockhead 1980; Herrmann and Pearle 1981; Indow and Togano 1970; Johnson et al. 1951; Millsap and Meredith 1987; Rubin and Olson 1980). Unconstrained free recall is a method of obtaining data about a person's knowledge of a particular domain in an unobtrusive manner (see Rubin and Olson 1980, 354–55) and is not intended to mimic a job-related situation.[10] To this end, the current study employs unconstrained rather than constrained free recall[11] so that the probability of recall, the timing of recall, and the order of recall would be determined by the subject's memory organization and retrieval strategies alone and would not be affected by the content and structure of a presented list (see Pellegrino and Ingram 1979, 35–36; Rubin and Olson 1980, 354). Employment of this task in the tests of hypotheses 1 and 2 can be viewed as an extension of the limited previous auditing research on experience and memory (Frederick 1991; Libby and Frederick 1990; Weber 1980).

In this task, subjects were allowed 15 minutes to list, in order of recall, as many different errors as possible that might occur in the sales-receivables-cash receipts cycle of a typical wholesaling or manufacturing company. Each subject was provided with lined sheets of paper to record the errors and the time when she or he completed recording each error[12] (see appendix A for a copy of the instrument). The time clock was a videotape that displayed the number of seconds that had passed since the beginning of the task. It ran from 000 to 900. This method of recording time has been employed previously by Hutchinson (1983).[13]

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[9] One junior-level subject who accidentally skipped a page of the instrument was deleted from the analysis in task 2.

[10] Nevertheless, the task is similar in nature to the consideration of errors that occurs at the planning stage of the audit.

[11] Previous auditing research (Frederick 1991; Weber 1980) has employed constrained free recall tasks to study memory organization. In constrained free recall, a list of items is presented, and the subject is later asked to recall the items in the list.

[12] The time between each item in the recall protocol was calculated to construct similarity matrices for each subject. To determine whether any dimensionality or related clusters in the data could be identified, analysis of a more exploratory nature—multidimensional scaling (MDS) and cluster analysis—was performed upon these similarity matrices (see Tubbs 1988 for details).

A fairly comprehensive list of 44 errors that could occur in the sales-receivables-cash receipts cycle of a wholesaling or manufacturing firm was identified by the experimenter by reviewing various auditing textbooks and the audit manuals of five Big Eight firms (see table 1). Each item in each subject's recall protocol was coded as either one of the 44 errors on the list or as an incorrect item.[14]

Coding was performed by the experimenter and an accounting graduate student with experience in the audits of manufacturing firms. Each coder independently coded each subject's recall protocol. Inter-rater reliability, or the total number of agreements divided by the total number of items across all subjects, was 0.815. Kappa, the "proportion of joint judgments in which there is agreement, after chance agreement is excluded" (Cohen 1960, 46) was 0.777 ($Z=73.911$, $p \leq 0.001$). The coders subsequently discussed and reconciled any items on which they disagreed.

Information from the recall protocols (i.e., the list of items recalled) was used to test the first three hypotheses. The total number of errors recalled by each subject that were not incorrect or repetitions of earlier mentioned items served as a surrogate for the number of items known and was used as the dependent variable for testing hypothesis 1. This measure is a reasonable surrogate because the number of items recalled is considered to be directly related to the number known (see, e.g., Indow and Togano 1970; Millsap and Meredith 1987). The ratio of the number of items that were coded as incorrect to the total number of items retrieved that were not repetitions for each subject served as the dependent variable for testing hypothesis 2. To test hypothesis 3, the frequency with which each specific error occurred in the recall protocols of all the subjects was recorded (see table 1). These numbers were then divided by the total number of subjects to arrive at the percentage of subjects who recalled that particular error. This percentage is referred to as item dominance (or production frequency), and this measure is a commonly accepted surrogate for typicality (see, e.g., Barsalou 1985; Loftus 1973; Mervis et al. 1976).[15] Minimum item dominance, the smallest dominance score for a subject, served as the dependent variable for testing hypothesis 3.

Task 2—Conditional Prediction

Task 2 employs a conditional prediction task to test hypotheses 4 and 5. This task has not previously been employed in the study of experience but was employed by Johnson and Tversky (1984) to study the mental representations of a specific domain of knowledge, the prevalent causes of death. The task should be fairly realistic for an auditor because it is analogous to discovering an error during testing, thereby resulting in the auditor deciding how to alter or extend procedures to detect related errors. This

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[13] There are other methods for recording temporal distance (see Bousfield and Sedgewick 1944; Gruenewald and Lockhead 1980; Millsap and Meredith 1987), but the results of Hutchinson (1983) are similar to those obtained with these other methods.

[14] Incorrect items included items that did not refer to the sales, receivables, and cash receipts cycle (e.g., "overstating cash by the use of two or more bank accounts") and items that did not meet the definition of a specific error or irregularity (e.g., "improper segregation of duties").

[15] Chang (1986), in a review of semantic memory research, discusses the relative status of the two major methods for assessing typicality, production frequency and ratings. The arguments for and against each measure do not allow a clear preference (p. 206), but item dominance is the measure that has been employed most often (p. 201). These measures have been consistently found to be highly correlated (see, e.g., Barsalou 1985; Chumbley 1986; Mervis et al. 1976).

Table 1
Errors and Their Frequency of Occurrence

Error Number	Error	Frequencies				
		Students	Juniors	Seniors	Managers	Total
1	Orders accepted and goods shipped to poor credit risks or unauthorized customers.	22	7	13	7	49
2	Orders accepted at terms other than those authorized by management.	5	6	6	7	24
3	Order specifications may not be met as to type and quantity.	4	3	6	6	19
4	Excessive and unwarranted granting of credit under kickback arrangement.	0	1	0	0	1
5	Sales invoice incorrectly priced or extended.	10	6	5	8	29
6	Management, employees, or third parties receive products or services without being billed or at unauthorized reduced rates.	2	3	5	0	10
7	Customers billed at incorrect amounts.	1	5	2	7	15
8	Billings recorded but goods not shipped.	2	4	7	9	22
9	A/R aged incorrectly; potentially uncollectible amounts not recognized.	10	23	15	17	65
Error in recording sales in sales journal:						
10	Not recorded (shipped not billed).	17	10	12	10	49
11	Recorded twice.	0	2	4	5	11
12	Wrong amount.	2	7	4	3	16
13	Wrong period.	6	15	11	16	48
14	Error in posting sales/accounts receivable to general ledger.	7	13	11	14	45
15	Fictitious sales.	15	14	11	14	54
16	Failure to record recoveries on accounts written off.	0	2	2	3	7
Error in posting accounts receivable to subsidiary ledger:						
17	Wrong amount.	2	3	0	0	5
18	Wrong period.	1	5	1	1	8
19	Wrong account.	5	6	4	6	21
20	Not posted.	5	4	3	0	12
21	Posted twice.	0	1	1	0	2
22	Checks not properly endorsed upon receipt.	4	4	4	3	15
23	Accompanying checks may not agree with prelist from mailroom.	5	5	6	4	20
24	Cash or checks lost.	1	0	1	1	3
25	Cash receipts not deposited on a timely basis.	3	6	4	4	17

(Continued)

Table 1—*Continued*

Errors and Their Frequency of Occurrence

Error Number	Error	Frequencies				
		Students	Juniors	Seniors	Managers	Total
Error in recording of cash receipts in cash receipts journal:						
26	Not recorded.	5	10	4	2	21
27	Recorded twice.	0	1	0	1	2
28	Wrong amount.	1	4	1	3	9
29	Wrong period.	2	7	6	6	21
30	Cash receipts recorded as sales rather than applied to A/R.	0	1	1	1	3
31	Collections on account misappropriated.	9	13	13	13	48
Error in posting cash receipts to accounts receivable subsidiary ledger:						
32	Not posted.	4	5	7	4	20
33	Posted twice.	0	1	0	1	2
34	Wrong amount.	2	2	2	1	7
35	Wrong account.	6	11	10	15	42
36	Wrong period.	0	0	1	2	3
37	Lapping.	14	10	5	12	41
38	Accounts improperly written off to cover misappropriation of receipts.	6	5	5	5	21
39	Returns or other allowances misclassified or not recorded.	5	16	9	14	44
40	Returns not recorded in proper period.	0	1	2	4	7
41	Credits issued for returns or allowances not earned or otherwise not according to company policy.	16	5	6	10	37
42	Records may be destroyed, stolen, or lost.	6	3	4	1	14
43	Overstatement of revenues where right of return or warranties exist.	0	2	3	6	11
44	Mathematical errors in computing a customer's balance.	2	0	0	2	4

task is meant to provide, in comparison with task 1, a more suitable test for the presence of characteristics supposedly acquired with auditing experience, such as "better cross-referencing" (Bedard 1989, 115) and knowledge of "event co-occurrences" (Waller and Felix 1984, 398).

The 44 errors described in task 1 were classified according to a number of dimensions, including the internal control objective violated, the department in which the error occurred, the accounts affected, and the audit procedure appropriate to discover the error. The dimensions of primary interest, because of their probable relation to causal reasoning, were the internal control objective violated and the department in which the error occurred. Because of the nature of the task and the large number of responses required, only eight items from the original list of 44 were included. These were chosen to satisfy the following criteria. First, two errors each originated in the following four departments: sales order (errors 4 and 7 in the first set listed in appendix B), billing (3 and 6), general accounting (2 and 8), and cash receipts (1 and 5). Second, two errors each could have violated the following four internal control objectives: validity (3 and 8), authorization (1 and 7), completeness (5 and 6), and valuation (2 and 4). Third, there was no ambiguity for these errors as to classification upon either dimension: department or internal control objective. Two colleagues with extensive auditing experience confirmed the classification of these eight items on these two dimensions and noticed no ambiguity in these classifications. Fourth, no two errors could share the same department and the same internal control objective.

Each subject was presented with the list of eight errors (see appendix B for a copy of a portion of the instrument). The subjects were asked to estimate the probability of occurrence of each error, $P(E_i)$, where $i=1$–8, for a typical company. Each subject was then told that during an audit a particular (target) error, E_j, where $j=1$–8, was discovered. The subject was then asked to re-estimate the probability of occurrence of the other seven (judged) errors, $P(E_i|E_j)$, where $i \neq j$. All eight items were used as targets for each subject. The order of the targets was randomized and the judged errors were presented alphabetically. Therefore, each subject made 56 (8×7) conditional predictions. These data were used to form the subject's prediction matrix: an 8×8 matrix with no entries along the diagonal. Each entry in the matrix is the conditional probability of the error minus the base rate probability of occurrence of that error, $[P(E_i|E_j) - P(E_i)]$, whre $i \neq j$. This measure was chosen because it was thought to reflect the auditor's change in belief upon the receipt of new information. Because the set of eight errors contains two errors each from four internal control objective categories and two each from four department categories, each subject's prediction matrix will contain eight entries in which both the target and the judged error share the same objective and eight entries in which they share the same department.

III. Results

Quantity and Quality of Errors

To test the first hypothesis, the numbers of errors recalled by the subjects in task 1 were compared across experience levels. Incorrect items and repetitions of items were not counted. The median numbers of errors retrieved by the different levels of subjects are presented in table 2. A 44 percent increase in average recall occurs between students and managers (from 8 to 11.5). The large-sample approximation of the Jonckheere test (see Hollander and Wolfe 1973) on the four levels yielded a Z-statistic equal to 2.652.[16] This result allows rejection of the null hypothesis of equal treatment effects in

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[16] The Jonckheere test is a non-parametric test of ordered alternatives (trend). A distribution-free test was employed in testing all of the hypotheses because a parametric trend analysis requires that the independent variable be quantitative in nature and that the sizes of the intervals between treatment levels can be specified (Kirk 1982, 150). This requirement is not met for level of experience, the independent variable in this experiment.

Table 2
Experimental Results—Task 1

Hypothesis	Dependent Variable	Jonckheere Z-statistic	Level	Median	
1	Items recalled	2.652[a]	Students	8.00	A
			Juniors	9.00	A
			Seniors	10.00	A C
			Managers	11.50	B C
2	Percentage of incorrect items	2.552[a]	Students	0.500	A
			Juniors	0.435	A
			Seniors	0.364	A C
			Managers	0.321	B C
3	Minimum item dominance	2.289[b]	Students	0.147	A
			Juniors	0.084	B
			Seniors	0.105	B
			Managers	0.084	B

Note: For each hypothesis, medians followed by the same letter are not significantly different at $\alpha<0.05$.

[a] Significant at $\alpha<0.01$.
[b] Significant at $\alpha<0.05$.

favor of the alternative hypothesis of increasing treatment effects (at $p\leq 0.004$), and is indicative of a strongly significant experience effect. The Spearman correlation between years of audit experience and errors recalled ($r=0.293$; one-tailed $p\leq 0.002$) provides additional support regarding the strength of this relationship. To examine which treatment effects were significantly different from each other, the large-sample approximation of the one-sided Wilcoxon rank sum test (see Hollander and Wolfe 1973) was performed on all six pairwise comparisons. The following treatment effects were significantly different: students versus managers ($Z=2.489$; $p\leq 0.006$) and juniors versus managers ($Z=2.609$; $p\leq 0.005$). Therefore, students and juniors seem to form a different group from managers.

To test the second hypothesis, the number of items that were coded as incorrect items divided by the number of non-repetition items retrieved were compared across experience levels. The median percentage of incorrect items of the different levels of subjects are presented in table 2. The large-sample approximation of the Jonckheere test on the four levels yielded a Z-statistic equal to 2.552. This statistic allows rejection of the null hypothesis of equal treatment effects in favor of the alternative hypothesis of decreasing treatment effects (at $p\leq 0.005$), and is indicative of a significant experience effect. In addition, the Spearman correlation between years of experience and percentage of incorrect items is -0.274 ($p\leq 0.004$). The large-sample approximation of the one-sided Wilcoxon rank sum test was performed on the six pairwise comparisons, and the following treatment effects were significantly different: students versus managers ($Z=2.330$; $p\leq 0.010$) and juniors versus managers ($Z=1.684$; $p\leq 0.046$). Therefore, students and juniors seem to form a different group from managers for this measure as well.

Typicality of Errors

To test the third hypothesis, the minimum item dominance of each subject's recall protocol was compared across experience levels. This variable was expected to decrease with experience, and the median scores for the different levels of subjects are presented in table 2. The large-sample approximation of the Jonckheere test on the four levels of minimum item dominance yielded a Z-statistic equal to 2.289. This allows rejection of the null hypothesis of equal treatment effects in favor of the alternative hypothesis of decreasing treatment effects (at $p \leq 0.011$), and is indicative of a significant experience effect.[17] The Spearman correlation between years of experience and minimum item dominance is −0.236 ($p \leq 0.011$). The large-sample approximation of the one-sided Wilcoxon rank sum test was performed on the six pairwise comparisons, and the following treatment effects were significantly different: students versus juniors ($Z=1.976$; $p \leq 0.024$), students versus seniors ($Z=1.873$; $p \leq 0.031$), and students versus managers ($Z=2.687$; $p \leq 0.004$). Apparently, knowledge of atypical errors does increase with experience, but it seems as if many of the atypical errors are learned fairly early in the auditor's career.[18]

Control Objectives

The fourth hypothesis suggests that the control objective violated when an error occurs is a feature that becomes relatively more salient with experience. The dependent measure, D_o, for testing this hypothesis is the difference between the mean of the eight entries in the subject's prediction matrix for which the target and the judged error share the same internal control objective and the mean of the 40 entries in the matrix for which the target and judged errors share neither the same objective nor the same department.[19] This variable was expected to increase with experience. To test this hypothesis, D_o was compared across experience levels. The median values of this variable for the different levels of subjects are presented in table 3. The large-sample

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[17] Another dependent measure considered for testing hypothesis 3 was average item dominance, the sum of the dominance scores for the items that the subject recalled divided by the number of items that the subject recalled. For this measure, the large-sample approximation of the Jonckheere test on the four levels of average item dominance yielded a Z-statistic equal to 1.156 ($p \leq 0.124$). Using this measure, the null hypothesis of equal treatment effects cannot be rejected. The fact that the results are stronger when minimum item dominance is employed as the dependent measure rather than average item dominance is not surprising. Typical items are expected to be known at all levels of experience; only the knowledge of atypical items is expected to increase with experience. When average item dominance is employed as the dependent measure, the fact that all experience levels are expected to recall the typical items tends to reduce the possibility of finding a significant result. The Spearman correlation between minimum item dominance and average item dominance is 0.592 ($p \leq 0.001$), which demonstrates the convergent validity of these two surrogates.

[18] Because it is possible that these typicality results were a function of greater recall by more experienced subjects, a chi-square test was performed on the 4 × 37 table. One dimension was the experience levels, and the other dimension was the error types with at least four responses (Fienberg 1980 suggests that, for tests conducted at a 0.05 level of significance, the goodness-of-fit statistics usually achieve the desired level of significance when the minimum expected cell size is approximately 1). If the typicality results were simply a function of the recall of more items by more experienced subjects, the expectation would be that the null hypothesis of independence could not be rejected. However, statistically significant chi-square statistics were achieved (chi-square: X^2 (108 d.f.) = 132.788, $p \leq 0.053$; likelihood ratio chi-square: $G^2 = 147.096$, $p \leq 0.007$). This suggests that the experience level groups do differ with respect to the distribution of error types.

[19] The mean of the unrelated cells was subtracted to serve as a control against subjects' unselectively increasing the probabilities of occurrence upon the discovery of an error.

Table 3
Experimental Results—Task 2

Hypothesis	*Dependent Variable*	*Jonckheere Z-statistic*	*Level*	*Median*	
4	D_o (control objective salience)	2.882*	Students	1.00	A
			Juniors	1.83	A
			Seniors	4.13	A C
			Managers	7.39	B C
5	D_d (department salience)	0.521	Students	1.63	A
			Juniors	2.59	A
			Seniors	4.20	A
			Managers	4.30	A

Note: For each hypothesis, medians followed by the same letter are not significantly different at $\alpha < 0.05$.

* Significant at $\alpha < 0.01$.

approximation of the Jonckheere test yieled a Z-statistic equal to 2.882. This allows rejection of the null hypothesis of equal treatment effects in favor of the alternative hypothesis of increasing treatment effects (at $p \leq 0.002$), and is indicative of a highly significant experience effect. The Spearman correlation between years of experience and D_o is 0.298 ($p \leq 0.002$). The one-sided Wilcoxon rank sum test was performed on all pairwise comparisons, and the following treatment effects were significantly different: students versus managers ($Z = 2.838$; $p \leq 0.002$) and juniors versus managers ($Z = 2.639$; $p \leq 0.004$). Students and juniors again seemed to form a different group from managers.

If the control objective were not a salient feature for a subject, the expected value of the dependent variable would be less than or equal to zero. Therefore, to determine the experience levels at which control objective was a salient feature, the large-sample approximation of the one-sided Wilcoxon signed rank test (see Hollander and Wolfe 1973) was performed on each experience level. The null hypothesis of no treatment effect was rejected for all four levels: students ($Z = 3.042$; $p \leq 0.001$), juniors ($Z = 3.142$; $p \leq 0.001$), seniors ($Z = 3.319$; $p \leq 0.001$), and managers ($Z = 4.074$; $p \leq 0.001$). Control objective seems to be a salient feature at all experience levels.

Department

The fifth hypothesis proposes that the "department" in which an error occurs is a feature that becomes relatively more salient with experience. The dependent variable, D_d, for testing this hypothesis is the difference between the mean of the eight entries in the subject's prediction matrix for which the target and the judged error share the same department and the mean of the 40 entries in the matrix for which the target and judged error share neither the same objective nor the same department. This variable was expected to increase with experience. To test this hypothesis, D_d was compared across experience levels. The median values of this difference for the various levels of subjects are presented in table 3. The large-sample approximation of the Jonckheere test on the four levels yielded a Z-statistic equal to 0.521 ($p \leq 0.301$). Therefore, the null hypothesis of no treatment effect cannot be rejected. The Spearman correlation between years of experience and D_d is 0.083 ($p \leq 0.214$).

To determine the experience level at which "department" was a salient feature, the large-sample approximation of the one-sided Wilcoxon signed rank test was performed on each level. The null hypothesis of no treatment effect was rejected for all four levels: students ($Z=3.437$; $p\leq 0.001$), juniors ($Z=3.894$; $p\leq 0.001$), seniors ($Z=2.728$; $p\leq 0.002$), and managers ($Z=3.523$; $p\leq 0.001$). This result and the results of testing hypothesis 5 imply that "department" is a salient feature that does not change in relative salience with experience.

IV. Disussion

A number of general conclusions can be made in regard to the results and how they relate to previous research. First, similar results were obtained regarding the quantity of knowledge retrieved (cf. Frederick 1991; Libby and Frederick 1990; Weber 1980) and the quality of knowlege retrieved (cf. Libby and Frederick 1990) with the more open-ended unconstrained free recall task, and this triangulation of research methods (Campbell and Fiske 1959) should increase confidence in previous results and the validity of the underlying theory. Second, support was found for increased knowledge of atypical items with experience. Typicality of response across experience levels has not been previously examined. Third, the richer and more audit-specific conditional prediction task permitted the study of two features of errors that appear to be related to causal explanation—internal control objective violated and the department in which the error occurred—and these were found to be salient. Previous auditing research (Libby 1985; Libby and Frederick 1990) has demonstrated that transaction cycle is a characteristic around which errors are organized. Fourth, task 2 demonstrated that the salience of the violated internal control objective increased with experience, whereas the salience of the department in which the error occurred did not appear to increase with experience. Thus, it appears that differential shifts in feature salience can occur with increases in experience. Finally, differences between students and auditors do not account for all of the experience effects found, unlike results in much of prior auditing research (see Ashton and Kramer 1980).

A number of possible limitations of this research exists. First, because experience level is observed rather than manipulated, sample-selection bias might provide an alternative explanation for the results. It is possible that auditors who were promoted are more intelligent or more motivated in the experimental setting.[20] Second, while the number of items recalled in an unconstrained free recall task is considered to be directly related to the number of items known (see section II), differences in recall facility across experience levels provide an alternative explanation for the results related to hypothesis 1. Third, an alternative method of measuring typicality could have been used to test hypothesis 3. In addition to evaluation of typicality with item dominance scores derived from the responses of the subjects, one possibility includes calculating item dominance scores for an independent group. Fourth, although the eight items employed in task 2 were carefully selected and verified as unambiguous in terms of the two dimensions of interest, it is possible that the presumed dimensions are equivocal or that alternative dimensions present in these items affected the results in the tests of hypothesis 4 and 5.[21] The tests performed, therefore, were based on the assumption that these alternative features were randomized across the set of items employed and were not confounded with control objective and department. Fifth, an underlying assumption of this experiment is that the category examined, errors and irregularities, includes both financial statement misstatements and control deviations. It is possible that financial statement misstatements and control deviations are distinct categories that are not intertwined in memory, and this possibility might have affected the results.[22]

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[20] Anecdotal evidence does not support this explanation, and Marchant (1987) did not find a significant difference in general analogical reasoning ability between auditing students and experienced auditors. Further, the correlations between intelligence and experience have been found to be zero in other professions (see, e.g., Schmidt et al. 1988).

This project suggests the following possibilities for future research. First, evidence of an exploratory nature indicates that auditors focus on dimensions of errors other than the internal control objective violated and the department in which the error occurred (e.g., error versus irregularity, the account affected by the error). Explicit testing for the existence and effect of experience on these other dimensions is a possible extension of this study. Second, a longitudinal study in which subjects perform the two experimental tasks at different points in their careers would eliminate the possibility of a sample-selection bias. Third, one could examine whether any firm effects exist in the development of knowledge structure. This examination might aid in the explanation of how knowledge structures develop or, at least, how the work environment affects this development. Fourth, studies of how auditing experience affects the development of cognitive capacities other than the knowledge base are possible. These other cognitive capacities include: cognitive effort, the ability to analyze information, elaboration upon given information, and the ability to remember (Alba and Hutchinson 1987). Fifth, to complete the theoretical link between experience and performance, the effect of the identified differences in the knowledge base on behavior and performance in realistic audit settings could be examined. Finally, one might test whether training or decision aids can eliminate differences in knowledge structure. This has been demonstrated in other fields (Brown and Stanners 1983) and would likely be of interest to practicing auditors.

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[21] This was one of the reasons for also performing MDS and cluster analysis on the task 2 data. The exploratory analysis for tasks 1 and 2 confirms the importance of control objective and department as relevant features, but also suggests that other features, such as intent (error vs. irregularity) and the account affected by the error, are also important to auditors (see Tubbs 1988 for details).

[22] Supplementary analyses were performed to address this issue. Items 1, 2, 3, 22, 23, 25, and 42 from table 1 were classified as control deviations (and not financial statement misstatements) on the basis of classifications by four auditing professors who were in total agreement on 39 of 44 items. Results of tests of hypotheses 1, 2, and 3 did not qualitatively change when the seven control deviations were not included (classified as misunderstandings). In addition, results from task 1 and 2 cluster analyses on the separate experience levels were examined (see Tubbs 1988). For both tasks, the results were similar across experience level. Clusters often contained a control deviation and a financial statement misstatement, and no clusters contained only control deviations. These results seem to indicate that control deviations and financial statement misstatements are intertwined in memory.

Appendix A

Task 1 Instrument

List as many possible errors or irregularities as you can that could occur in the sales, receivables, and cash receipts cycle of a typical wholesaling or manufacturing company (be specific). You have 15 minutes to complete this task. After recording each item, look at the time clock in front of the room and record the number of seconds that have passed before continuing.

Errors or Irregularities	*Time*

(Instrument contained 75 lines on 3 pages for answers.)

Appendix B

Task 2 Instrument (Page 1)

Assume that you are part of the audit team examining the sales, receivables, and cash receipts cycle of a typical wholesaling or manufacturing firm. You may assume that the company's internal control system has been judged to be reliable in the past.

For such a client, what is your judgment of the probability (on a scale from 0 to 100) that a *material* error or irregularity of the following type could occur during the year under examination? [You might think of this as a judgment of how many such clients out of 100 would exhibit a material error or irregularity of the following type.]

1. Customers failed to pay within the discount period and remitted the payment in full. Nevertheless, discounts were approved, and the amount of the discounts were misappropriated. 1. ________
2. Accounts receivable were aged incorrectly; potentially uncollectible amounts were not recognized. 2. ________
3. Billings were recorded, but goods were not shipped. 3. ________
4. Customer order specifications were not met as to type and/or quantity. 4. ________
5. Lapping occurred. 5. ________
6. Management, employees, or third parties received goods without being billed. 6. ________
7. Orders were accepted in violation of the company's credit policies. 7. ________
8. Revenues were recorded in the currrent period when they should have been recorded in the next period. 8. ________

Task 2 Instrument (Page 2)

Treat pages 2 through 9 as *totally independent situations.*

Now assume that during the audit of the sales, receivables, and cash receipts cycle of the client described on page 1, the following *material* error or irregularity was discovered:

Orders were accepted in violation of the company's credit policies.

In light of this discovery, what now is your judgment of the probability (on a scale from 0 to 100) that a material error or irregularity of the following type could occur during the year under examination? (You may look back at page 1 if you wish.)

1. Customers failed to pay within the discount period and remitted the payment in full. Nevertheless, discounts were approved, and the amount of the discounts were misappropriated. 1. ________
2. Accounts receivable were aged incorrectly; potentially uncollectible amounts were not recognized. 2. ________
3. Billings were recorded, but goods were not shipped. 3. ________
4. Customer order specifications were not met as to type and/or quantity. 4. ________
5. Lapping occurred. 5. ________
6. Management, employees, or third parties received goods without being billed. 6. ________
7. Revenues were recorded in the current period when they should have been recorded in the next period. 7. ________

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The Relation of Judgment, Personal Involvement, and Experience in the Audit of Bank Loans

Cynthia Jeffrey
Iowa State University

SYNOPSIS AND INTRODUCTION: The quality of bank portfolios has declined in recent times, and allegations have been made that auditors have failed to detect material overstatements of the value of bank loan portfolios (McCoy et al. 1990; Thomas and Ricks 1990), lawsuits have sought to hold auditors liable for the misleading financial statements (Bailey 1987; Finn 1984), and audit firms have been censured by the SEC for improper professional conduct in the audits of banks (Grisdela and Berton 1987).

This research examines the evaluation of the bank loan portfolio, a critical and high-risk component of the audit of banks. The Allowance for Credit Losses "should be adequate to cover specifically identified loans, as well as loans and pools of loans for which losses are probable but not identifiable on a specific loan-by-loan basis" (AICPA 1986, 3).

The focus of this research is the effect of participation in sequential audits on auditors' loan evaluation judgments. The sequential nature of audit judgments is an important consideration, but previous research has considered only the sequential nature of individual audit tasks (see, e.g., Ashton and Ashton 1988; Cushing and Loebbecke 1986; Gibbins 1984). To date, research has not focused on the fact that audits themselves are sequential; most audits are repeat engagements, and the same auditors participate in the audit year after year.

A theoretical framework for the effect of personal involvement on judgment (Kiesler 1971; Staw 1976; Staw and Ross 1987) suggests that personal involvement fosters commitment and an escalation of commitment occurs when there is personal responsibility for a series of judgments.

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The current research extends previous studies by evaluating the effect of personal responsibility in a professional environment with experienced subjects performing a realistic task.

The literature suggests that experience could significantly affect the tendency of subjects to escalate their commitment to a chosen course of action. Experience is expected to improve judgments when (1) the decision maker is exposed to a variety of exemplars so that information about relative frequencies is learned, (2) the task is sufficiently complex and is either semistructured or unstructured, and (3) feedback on decisions is available. These conditions are all present for loan riskiness evaluations by auditors.

Previous research results also indicate that experience may improve judgments by mitigating the effect of cognitive heuristics on judgments (see, e.g., Libby et al. 1985; Shields et al. 1987). Mechanisms leading to these results include (1) improved probabilistic reasoning as a function of experience, (2) incentives to learn decision rules with accountability for judgments, and (3) sensitivity to evidence. Ashton and Ashton (1988, 1990) indicate that experienced auditors are particularly sensitive to evidence.

Like many other audit decisions, loan evaluation involves sequential judgments. The research reported here seeks to determine (1) whether personal involvement in sequential audits leads to an escalation of commitment to previous loan evaluation decisions and (2) whether experience in the audit environment diminishes or eliminates any negative consequences of personal responsibility. Personal involvement is manipulated across two groups of independent auditors, and audit experience and loan evaluation judgments are elicited. It is hypothesized that the interaction between personal involvement and experience affects the loan evaluation judgment. When there is a high level of personal involvement, the loan evaluation judgments of inexperienced auditors are predicted to be more favorable than those of experienced auditors; when there is a low level of personal involvement, no differences between the judgments of experienced and inexperienced auditors are predicted.

Based on experimentation with 41 auditors, the results indicate that a significant interaction does exist. Escalation behavior in loan evaluation judgments was evident in the evaluations of inexperienced auditors; experience mitigates the escalation effect.

Key Words: *Escalation of commitment, Experience, Loan evaluation, Bank audits.*

Data Availability: *Data are available from the author on request.*

IN the remainder of this article, section I covers the theoretical and hypothesis development. The experiment is described in section II. Finally, section III provides concluding remarks and a brief discussion.

I. Theoretical Development and Hypothesis

Overall Effects of Personal Involvement on Judgments

Personal involvement in the decision process can have both positive and negative effects on judgments. Positive effects may result because personal involvement increases task-specific experience and knowledge. An important type of knowledge gained from experience is knowledge of the relative frequencies of events (see Hock and Hasher 1990 for a review). Increased familiarity generally results in better performance by improving one's ability both to (1) isolate the information that is most important and task-relevant and (2) analyze the information (Alba and Hutchinson 1987). In the audit of loans, personal involvement in the decision process should provide auditors with information about the relative frequency of troubled loans in a portfolio and enable them to identify and evaluate factors that threaten loan collectibility.

Personal involvement has negative consequences for the decision process when overconfidence in knowledge, ability, and judgments results from increased involvement (Oskamp 1982); in auditing, overconfidence may lead to less thorough reviews. Personal involvement also may lead to commitment, which is defined as "the binding of the individual to behavioral acts. . . . The effect of commitment is to make an act less changeable" (Kiesler and Sakumura 1966, 349). Commitment also makes "the cognition representing the behavior more resistant to change" (Kiesler 1971, 31). There is evidence that people will act in an particular way merely as a consequence of having previously acted in the same manner (Salancik 1977); furthermore, as the number of acts increases, commitment often escalates (Kiesler 1971; see also Staw and Ross 1978 for a review). In the audit of bank loans, personal involvement in sequential loan evaluations may encourage auditors to make a judgment of loan collectibility that is consistent with their previous judgments. To the extent that an escalation of commitment fosters biased judgments, the effect of personal involvement in the decision process is negative.

Escalation of Commitment

Kiesler (1971, 33) suggests that commitment is increased, or escalates, with (1) the explicitness of the act, (2) the irrevocability of the act, (3) the act's importance for the subject, (4) the freedom of choice perceived by the decision maker, and (5) the number of acts performed. In the audit environment, loan evaluation judgments are documented in the working papers and are therefore explicit and irrevocable. Further, auditors at all levels agree that the evaluation of loans is an important part of the bank audit. Auditors are expected to use their best judgment when evaluating these loans, and so have freedom of choice in arriving at their loan evaluation judgments. Finally, current audit practice is characterized by a large number of repeat audit engagements and by a degree of continuity in audit team personnel over time.

In a given audit, it is common for at least some members of the audit team to have been personally involved in the prior year's audit, and these auditors may become committed to their previous judgments. To the extent that relevant information is recorded in the working papers, auditors with no prior involvement but with access to the prior year's working papers possess the same information as those with prior involvement. The key difference lies in whether the initial evaluations were self-generated or were made by a different auditor.

Little research has attempted to determine the underlying mechanisms whereby an escalation of commitment influences judgments. One possibility is that decision makers process information differently when initial judgments were self-generated. Libby and Trotman (1991) present results that the attention and relative recall of information by auditors engaged in sequential decision making is biased in the direction of facts that are supportive of, or consistent with, their initial judgments. Tan (1991) demonstrated that auditors paid differential attention to evidence consistent with their prior decisions. Church (1991) demonstrated that auditors committed to a hypothesis regarding the source of an error allocated more time to investigate that source. Differential use of information may explain the effects of commitment on judgment.

Decision makers who expect to justify their decisions may be motivated to demonstrate consistency in judgment (Hagafors and Brehmer 1983), which would encourage escalation behavior. In accounting, there is some evidence that prior involvement with an audit client creates social pressures or incentives to remain consistent in judgments across time. Auditors have been shown to underestimate the seriousness of a malfunction in the internal control system when they had previously evaluated the system (Plumlee 1985).

Kanodia et al. (1989) suggest that the escalation effect may be explained by economic factors. Specifically, there may be incentives for a decision maker not to reveal private information about negative outcomes. When a decision maker changes a prior decision, one interpretation is that the original decision was flawed. Because inconsistencies between current and prior decisions may reveal information about the quality of prior decisions that could affect the decision maker's reputation, the decision maker may be reluctant to make a decision that varies significantly from a previous one. In a loan evaluation context, changes in judgments over time may reflect inadequate performance in the past. Loan evaluation judgments are clearly documented in the working papers, and evaluations that indicate deteriorating loan quality are likely to be noticed and to require justification. Previous involvement in the loan evaluation process may induce a tendency to make subsequent decisions conform to a prior evaluation.

Research on Escalation of Commitment

Staw (1976) presents results consistent with the five determinants of escalating commitment posited by Kiesler (1971). Staw tested the hypothesis that effects of escalating commitment on judgments would occur as a function of the level of personal responsibility. Personal responsibility as defined by Staw encompasses the first four items identified by Kiesler; namely, explicitness and irrevocability of the act, the act's importance for the subject, and the freedom of choice perceived by the decision maker. Kiesler's fifth determinant, the number of acts performed, is used by Staw to differentiate between judges with high personal responsibility, that is, those making two or more sequential decisions, and those with low personal responsibility, who are making only a single decision.

Staw also posited that effects of escalating commitment on judgment would occur as a function of decision outcomes. He defined a positive outcome as one in which the results of a previous decision meet expectations; conversely, a negative outcome is one in which the results of a previous decision fail to meet expectations. On the basis of his results, Staw concluded that decision makers who have personal responsibility for action choices that result in *negative* outcomes make subsequent choices that are more favorable to their previously chosen course of action than do individuals with no personal responsibility for previous action choices.

Studies on escalation of commitment consistently document the existence of this effect (see Staw and Ross 1987 for a review). These studies have focused on escalation behavior conditioned on negative outcomes. The strength of the results suggests that negative outcomes are a determinant of escalation behavior; additionally, increasing commitment with negative outcomes is potentially a more serious problem than increasing commitment when positive outcomes are achieved. Although numerous studies on escalation behavior indicate the possible existence of a large number of determinants of this effect and of possible moderating variables, Staw and Ross (1987, 65) state, "To date, the only findings approaching established status are those from project determinants manipulating obvious cost/benefit factors and from replications of the effects of personal responsibility. Our confidence in other determinants relies either on single studies or on validation from related social science literature."[1]

In summary, the review of the research on escalation of commitment suggests that auditors may be susceptible to escalation behavior and that it is most likely to occur when (1) sequential evaluations about a course of action are made, (2) the decision maker has personal responsibility for a previous favorable decision, and (3) the outcome is negative; that is, the results of the chosen course of action do not live up to prior expectations. Although other determinants have been hypothesized and tested, the results for these factors are robust.

Escalation of Commitment and the Audit Environment

Discussions with the partner-in-charge of a large midwestern office of the Big 6 firm that participated in the experiment provided a description of auditor loan evaluation judgments. These discussions were used to determine *ex ante* the existence in the audit environment of sequential evaluations, personal responsibility, and negative outcome.[2]

Sequential evaluations are the norm. A bank is likely to retain the same audit firm annually. Although competition for clients is intense among large audit firms, it is very unusual for a large bank to change auditors.

Personal responsibility for sequential judgments results because continuity in audit team personnel is a goal of the audit firm. Auditors are likely to participate in sequential audits of individual clients, and the same auditor is likely to evaluate the loans in the bank's portfolio in consecutive years.

Escalation behavior in loan evaluations is most likely to occur if a deteriorating loan in the bank portfolio is perceived as a negative outcome by the auditor. The partner-in-charge stated that the audit firm is concerned with detecting troubled credits and with determining a fair representation of the Allowance for Credit Losses, but it is *not* a positive outcome when an auditor detects a troubled loan that has not been previously identified as such. The detection of a troubled credit may signal a need for increased audit work, and this may affect the profitability of the audit because the additional time required may not be billable. In addition, there may be some difficult meetings with the client if the detection of additional troubled credits leads the audit firm to require larger charges to the Allowance for Credit Losses and the Bad Debt Expense than had previously been anticipated. Disagreement with the client about the need for adjustment may strain the client relationship. The attitude expressed by the partner may be exacerbated by strong pressures on audit firm profitability and a sharp rise in competition among audit firms[3] (Berton 1991). To the extent that detection of deteriorating loans is not perceived as a negative outcome by individual auditors, escalation behavior is less likely and the likelihood of finding significant results is reduced.

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[1] Three independent lines of research on commitment in escalation situations have evolved from the study by Staw (1976). Results presented by Teger (1980), by Brockner and his associates (Brockner et al. 1987, 1986; Brockner and Rubin 1985), and by Staw and his associates (Staw and Ross 1980; Staw and Fox 1977) consistently document the existence of escalation behavior.

[2] The descriptions of loan evaluation judgments in this study are specific to this particular audit firm and generalize to other audit firms only to the extent that these audit practices are similar across firms.

Role of Experience

Experience and the Loan Evaluation Judgment. Research in psychology has demonstrated that a person with more experience in a substantive area has more items in memory (Hayes-Roth and Hayes-Roth 1975; Hutchinson 1983; Murphy and Wright 1984) and develops a good understanding about the relative frequency of events (Hock and Hasher 1990). Further, increased experience results in a more complicated category structure (Weber and Crocker 1983).

These results have been replicated in a professional audit environment. Experienced auditors make better relative frequency judgments in professional tasks than do inexperienced ones (Butt 1988). Experienced auditors also are better able to identify errors in analytical review (Marchant 1989), exhibit more complete knowledge of financial statement errors, and generate a greater quantity of accurate explanatory hypotheses (Libby and Frederick 1991). They also generate more plausible and fewer implausible explanations for errors in the financial accounts, and are able to categorize errors based on the audit objective and the structure of the underlying accounting system (Libby et al. 1988). Tubbs (1990) demonstrated that as auditors become more experienced, (1) they become aware of more errors, (2) they have fewer misunderstandings about errors, (3) they become aware of more atypical errors, and (4) the causally related features of errors, such as department in which the error occurred and the internal control objective violated, become relatively more salient.

Experience is expected to have the greatest effect on judgment when the task is ill-structured and complex (Abdolmohammadi and Wright 1987) and when feedback is available (Hoch and Loewenstein 1989). Professionals uniformly agree that loan evaluation is a complex, ill-structured task that requires subjective professional judgment, so experience in this domain can be expected to influence judgment. Feedback is also available. Loan evaluations are reviewed all the way up to the partner level; the review process monitors both the quality of the work performed and its conformance with professional and firm standards (AICPA 1979) and provides feedback to auditors. Additional feedback is available to auditors who evaluate the same loan portfolio over a period of years.

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[3] Questions may arise about whether identifying a loan as troubled is a negative outcome for an auditor or whether an auditor might think that this would demonstrate technical competence and therefore be rewarded. Preliminary research (Holt and Jeffrey 1992) indicates that finding a material misstatement is perceived as significantly less important for career advancement than servicing the needs of an existing client ($p=0.002$). Detecting troubled credits is indeed important for the effectiveness of the audit; nevertheless, it is still considered a negative outcome for the audit firm.

In loan review, auditors are likely to review many loans in the course of even a single audit. Auditors are therefore exposed to extensive and varied loan information and are likely to have developed significant knowledge about categories of collectible and uncollectible loans, the features associated with these loans, and the relative frequency of collectible and uncollectible loans. Knowledge gained from experience therefore has the potential to affect loan evaluation judgments.

Experience and Escalation of Commitment. There are no published studies to date on the role of experience in escalation behavior, but research results indicate that increased experience may mitigate biases in judgment. Experience has been found to mitigate cognitive heuristics in a number of studies (Joyce and Biddle 1981a, 1981b; Kinney and Uecker 1982; Libby et al. 1985; Shields et al. 1987). Nisbett et al. (1983) found that experience allows judges to recognize heterogeneity of events and to improve their probabilistic reasoning. Results in a series of studies by Tetlock and his colleagues (Tetlock 1983a, 1983b, 1985; Tetlock and Boettger 1989; Tetlock and Kim 1987) indicate that accountability for judgments leads to more complex thought, and that this increased complexity of thought confers resistance to well-known judgmental biases.

Auditors are accountable for their judgments to superiors in the firm, to the client, and to the outside users of financial statements. Results reported in the accounting literature tend to support the hypothesis that experience mitigates judgmental biases. Rodgers (1991) presents results that suggest that experience is a key to overcoming the anchoring bias. Anderson and Wright (1988) studied the influence of professional experience on the explanation effect and determined that novice, but not experienced, auditors exhibited the effect.[4] Recency effects in data evaluation were more pronounced for inexperienced auditors than for experienced ones (Messier and Tubbs 1990), and inexperienced, but not experienced, auditors were adversely affected by irrelevant evidence (Bamber et al. 1991). Auditors also seem to be particularly responsive to evidence, especially to evidence that does not support a current belief (Ashton and Ashton 1988, 1990). Ashton and Ashton demonstrate that "important aspects of the education and training of auditors, and of the legal and professional environment in which they work, may be expected to distinguish their approach to evidence evaluation from that of other groups" (1990, 3).

To summarize, the conditions for escalation behavior are present in the audit environment. However, experience is expected to mitigate escalation behavior in loan evaluation judgments. These findings lead to the research hypothesis:

H1: There is an interaction between experience, personal responsibility, and the loan evaluation judgment such that judgments of inexperienced auditors in the high personal responsibility condition will be more favorable than those of experienced auditors. In the low personal responsibility condition, there will be no difference in the judgments of inexperienced and experienced auditors.

II. The Experiment

Subjects

Forty-one independent auditors from a single Big 6 accounting firm participated in the experiment. Only auditors at the senior or higher level participated because firm policy requires that auditors be at least at the senior level before having responsibility for loan evaluation. All the auditors in the study normally spent 25 percent or more of their time working on audits of financial institutions, primarily banks. Auditors from four offices of the accounting firm participated in the study. There were no discernible differences in responses across the four offices, and at three of the four offices, there was 100 percent participation by qualified auditors. Auditors were randomly assigned to the experimental conditions (discussed below) with the constraint that cell sizes be approximately equal.

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[4] The explanation effect occurs when the generation of an explanation for an event increases the judged likelihood of the event.

Materials

Auditors who participated in this study completed two experiments on loan evaluation, only one of which is reported here. Subjects were randomly assigned to participate in either experiment 1 or experiment 2 first, with the constraint that half participate in experiment 1 first. Because there were two experiments, it was necessary to test for order effects; there were no significant order effects ($p > 0.40$).

The experimental materials consisted of (1) an instruction set, (2) a short sample loan with a loan evaluation worksheet, (3) the Wilderness Resorts case, and (4) a post-experimental questionnaire. The instructions outlined the scope of the task and indicated that responses would be confidential and that the results would be reported in the aggregate. A sample loan evaluation case was then presented to ensure that everyone understood the task and the form the responses should take.

The Wilderness Resorts case was developed for this research and is a credit file for a loan. Included in the file are the name of the borrower, type of business, amount outstanding, interest rate, origination date, maturity date, purpose, security, loan officer diary sheets, and financial statements. To provide assurance that the case provided a realistic representation of a company with a *deteriorating* credit position, the case was based on the past three annual reports of an actual company whose bond rating had been recently downgraded by both *Value Line* and *Standard & Poor's.*[5] The reasons for downgrading the debt cited by *Value Line* and *Standard & Poor's* were built into the case, but the size of company was reduced to insure that the debt could be financed by a single bank; the intent was to avoid the complexities of credit evaluations when multibank financing is used. In addition, the smaller company in the case would not be listed on a stock exchange, so auditors would not have information about how investment services would rate the company debt. The judgment of interest in the research is loan evaluation, not how auditors incorporate investment service information into these evaluations.

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[5] On the basis of 1985 financial information and projections for the first quarter of 1986, *Value Line* rated the actual company's long-term prospects as favorable as of March 31, 1986. By June 30, 1986, however, *Value Line* substantially revised this opinion and reported that prospects for the stock's future performance appeared to be poor. This is consistent with *Standard & Poor's* rating of the firm; on September 1, 1986, *Standard & Poor's* downgraded the debt from B to CCC – . Reasons cited by both *Value Line* and *Standard & Poor's* included a significant decrease in membership sales, which decreased by 47 percent from the prior year for the first six months of 1986. This was coupled with high operating costs, high marketing expenses, and a negative cash flow for the period. The decrease in membership sales was not seen as a temporary phenomenon, but was linked to (1) a general economic downturn that was responsible for a substantial reduction in recreational spending, (2) high gasoline prices, and (3) changes in marketing techniques in an attempt to reduce marketing costs. *Value Line* reported that it probably would be necessary for the company to sell some of its properties to maintain satisfactory working capital.

The post-experimental questionnaire elicited subjects' perceptions about the audit work environment and task realism. Personal information, including gender, educational background, and experience, was also collected.

Because half the subjects were told that the loan was clean (i.e., untroubled) as of February 1986, it is important that the loan actually be viewed as untroubled by professionals. The credit file was initially reviewed by four people: the partner-in-charge at the accounting firm, a senior vice-president at a major regional bank, the manager of the credit evaluation department at a major regional bank, and a federal bank examiner from the Office of the Comptroller of the Currency (OCC). All four evaluated the loan as untroubled as of February 1986. In addition, two senior managers from a major international audit firm worked through the materials under experimental conditions, and both evaluated the loan as good as of February 1986.

Procedures

At two of the four participating offices, the experiment was administered and controlled by the researcher. Auditors met in a conference room and spent approximately two hours completing the experiments. None of the 18 subjects who participated under these conditions had any unusual questions or expressed any difficulty in completing the experimental materials within the two hours allotted. At the remaining two offices, the secretary of the partner-in-charge administered the materials. There were no discernible differences between the responses in any of the groups of participants, and the partner-in-charge at each office personally requested the participation of the auditors. A summary of the results was promised to the partners and to the participants. Discussions with auditors after the experiment indicated a high level of interest in both the task and the results.

Operationalization of Variables

Personal responsibility is a categorical variable with two levels, high and low, and it was manipulated by varying the number of sequential judgments that subjects were required to make. Auditors in the high personal responsibility condition were asked to make two sequential decisions. These subjects were provided with a credit file complete through the end of 1985 and were asked to evaluate the loan as of February 1986. After making the initial judgment, the subjects received additional information that was added to the credit file during 1986, and they were asked to make a second loan evaluation as of February 1987.[6] Auditors in the low personal responsibility condition were provided with the complete credit file through 1986, including the information that the loan was considered by the previous auditor to be a good loan (i.e., collectible) as of February 1986, and were asked to evaluate the loan as of February 1987. The operationalization of personal responsibility is consistent with the extant literature on escalation of commitment (see, e.g., Bazerman et al. 1980, 1984; Caldwell and O'Reilly 1982; Staw 1976).

The second variable of interest, experience, was not manipulated but was measured. Discussions with the auditors indicated that firm-specific experience was more important than general experience as an auditor because of differences across audit firms, and the formal training was an important component of auditor experience. Because in-house training programs in this firm are related to rank, because the nature of the task-specific experience changes with rank, and because all the auditors who participated in the experiment spent a large percentage of their time working on bank audits, rank within the firm was chosen as the appropriate operational variable for the analysis.

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[6] The constraints of a laboratory experiment prevented the researcher from using a real time line and delaying the second loan evaluation judgment for a year. However, auditors normally have their working papers from the previous year available when making subsequent evaluations. Working papers contain the loan judgment from the previous year, and serve to remind the auditor about the previous evaluation. Given the use of working papers, the two-hour time frame of this experiment is a reasonable surrogate for the decision-making process in the audit environment.

In this research, seniors in the firm are categorized as inexperienced because auditors do not begin to make loan evaluation judgments until they are seniors and undergo formal training in loan evaluation. The mean (s.d.) experience reported by the seniors was 2.80 (0.83) years with the firm. Thus, in this research seniors will be inexperienced.

Managers or senior managers in the firm are considered experienced auditors. The mean (s.d.) experience reported by the managers and senior managers was 7.67 (2.61) years. Auditors are promoted to manager after approximately four years with the firm, at which time they are expected to be able to make loan evaluation judgments and to evaluate the judgments of seniors. For the auditors who participated in this experiment, rank in the firm was perfectly correlated with years of experience. The hypothesis that there is no difference in experience between the group is rejected ($p < 0.001$).

Audit firm procedures require auditors to make a dollar estimate of the amount to be included in the Allowance for Credit Losses for each loan; therefore, the dollar estimate to be included in the allowance for the loan to Wilderness Resorts was elicited in the experiment. The dollar estimate was then partitioned into two levels, judgments that the loan was either good or troubled. According to the auditors at the firm, loans perceived as good credits are treated differently than ones perceived to be troubled because troubled loans threaten the value of the loan portfolio. Estimates that 10 percent or less of the loan should be allocated to the Allowance for Credit Losses were categorized as judgments that the loan was good; estimates in excess of 10 percent were categorized as judgments that the loan was troubled.

There were several reasons for choosing a cutoff level of 10 percent of the total loan. First, a materiality threshold of 5-10 percent is common in accounting. Second, a measure of asset quality commonly used (Meeker and Gray 1987; Spong and Hoenig 1979) is a weighted classification statistic based on bank examiner classification categories. The classification categories as cited by the AICPA (1986) are:

1. Unclassified, or current loans are judged to be within the limits of acceptable banking risk.
2. Special mention loans are loans in which there has been some deterioration in the borrower's financial position, but collection is still judged to be probable. Regulators identify these loans as potentially weak. Loans in this category are said to be "criticized"; loans in any of the more severe categories are said to be "classified."
3. Substandard loans are loans that involve more than a normal risk because of the financial condition or unfavorable record of the borrower, insufficiency of collateral, or other factors noted by the examiner.
4. Doubtful loans are credits for which the ultimate collection is unlikely and a substantial loss is likely, but the loss is not yet definitely estimable.
5. Loss loans are loans that are regarded as uncollectible and as estimated losses that should be written off against the bank's capital.

Future charge-offs are estimated as the sum of 20 percent of substandard credits, 50 percent of doubtful credits, and 100 percent of loss credits. The amount to be allocated to the Allowance for Credit Losses for unclassified loans should therefore be less than 20 percent.

In the experiment, subjects were asked to categorize the loan into bank examination classifications. The total dollar value of the loan, $1 million, was assigned to categories ranging from 1 (good) to 5 (loss). A weighted-average classification rating was then calculated and used as the independent variable in a regression analysis. The dollar amount allocated to the Allowance for Credit Losses was the dependent variable. The relationship was significant ($p=0.05$), and the regression equation predicts that $98,000 which is approximately 10 percent of the outstanding loan balance, will be allocated to the Allowance for Credit Losses for loans categorized as special mention (category 2).[7]

Manipulation Check

Comparison of the loan evaluation judgments for the second evaluation as of February 1987 was valid only if it was reasonable to believe that all subjects would evaluate the loan as good as of February 1986 (the first loan evaluation decision). The professionals who reviewed the materials prior to the experiment indicated that the loan was untroubled. Also, because half the subjects (those in the high personal responsibility condition) evaluated the loan as of February 1986, it was possible to determine how many of these subjects evaluated the loan as untroubled as of February 1986. Of the 21 subjects in the high personal responsibility condition, 20 made an initial evaluation that the loan was good. Of these 20, 14 made a point estimate of zero dollars to be allocated to the Allowance for Credit Losses for this loan, and an additional three subjects allocated less than 1 percent of the loan balance to the allowance. One subject allocated 5 percent of the outstanding balance, and two subjects allocated 10 percent to the Allowance for Credit Losses. The hypothesis that the point estimate was less than or equal to 10 percent of the total loan value could not be rejected at the 0.05 level of significance; the more conservative hypothesis that the point estimate was less than or equal to 5 percent of the total loan value also could not be rejected at the 0.05 level of significance. All 21 subjects indicated that the minimum amount acceptable to allocate to the Allowance for Credit Losses for this loan was zero dollars. Furthermore, ten subjects indicated the *maximum* amount to be allocated for this loan was zero, and an additional five subjects felt the *maximum* allocation for this loan would be 10 percent or less of the outstanding loan balance. That subjects would evaluate the loan as good as of February 1986 was therefore confirmed.

Because half the subjects were told that the loan was previously evaluated as a good loan, the reliability of the judge who made the previous evaluation judgment is important. The auditors in the low personal responsibility condition were told that the previous evaluation was made by the audit team from the same firm that evaluated the loan the previous year. This meant that the evaluation judgment was subject to the normal firm review and quality control procedures. Discussions with the auditors indicated that, under these conditions, they believed the judgment was reliable.

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[7] According to the OCC, special mention credits are not classified. In a separate experiment (Jeffrey 1991), bankers were asked to evaluate the loan to Wilderness Resorts. Again, a regression was run with the loan evaluation judgment as the dependent variable and the weighted-average loan classification judgment as the independent variable. The relationship was significant ($p=0.004$), and the regression equation predicts a loan evaluation judgment of $102,000 for banker subjects who classify the loan to Wilderness Resorts as special mention. Because both bankers and auditors allocated approximately 10 percent of the total loan balance to Wilderness Resorts when they classified this loan as special mention, this amount was used as the cutoff level for categorizing the loan as good; amounts greater than 10 percent are categorized as judgments that the loan is troubled.

Because the subjects evaluated the loan as a good credit on the first evaluation date, examination of the judgment on the second evaluation date revealed which subjects still considered the loan as good and which had changed their evaluation and now considered the loan as troubled. The subjects who evaluated the loan as good on the second evaluation date were making judgments similar to their initial evaluation; this behavior is consistent with escalation of commitment.

Participants were also asked to evaluate the realism of the Wilderness Resorts case on a scale that ranged from 0, not realistic, to 10, extremely realistic. The mean (s.d.) response was 7.68 (0.91). There were no responses below 6.

Statistical Analysis and Results

The hypothesis is tested with a multivariate analysis of categorical data by using a loglinear model (BMDP Program 4F). This statistical technique examines relations among the categorical variables and is the appropriate model for multivariate categorical variables (Fienberg 1983). Unlike MANOVA and ANOVA models that assess the effects of independent variables on dependent measures, loglinear models test the structural relations among categorical explanatory and response variables (Fienberg 1983, 3). In the research reported here, experience and personal responsibility are the explanatory variables, and the loan evaluation judgment is the response variable. Because all of these variables are operationalized as categorical variables, the optimal model to test the research hypothesis is the loglinear model.

Loglinear analysis consists of a special class of models termed hierarchical models. In a hierarchical model, if the interaction of a set of variables is significant, each lower order term also must be significant for all possible combinations of these variables. For a three-variable model, this means that if the three-way interaction term is significant, the lower order two-way interactions and the individual main effects are also significant. To describe a hierarchical model, it is sufficient to list the highest order term in which variables appear. This is called the generating class of a model (Norusis 1985, 308). When the highest order term is tested and determined to be significant, the interpretation is that the relation among the variables is significant; that is, the levels of any one variable differ as the remaining variables change. Conditional models are then used to identify the specific relations between the response variable and the explanatory variables.

The appropriate statistic to test a hypothesis with the loglinear model is the likelihood ratio (Berenson et al. 1983, 492). The likelihood ratio is additive under partitioning for nested models (Dixon et al. 1985). A significant three-way interaction therefore indicates that all nested models are also significant at the same or lower level of significance. If the likelihood ratio for a three-way interaction is significant, the significant two-way interactions should be examined. Conditional likelihood ratios are calculated for the two-way interaction; the interactions are tested by examining the relation between the two variables in an interaction conditioned on each level of the third variable. The significance level of the conditional likelihood ratios defines the form of the relationship.

Table 1
Experience by Loan Evaluation Judgment Conditioned by Personal Responsibility

Panel A. Low Responsibility:

	Inexperienced n=13	*Experienced* n=7
Good Loan	62%	71%
Troubled Loan	38%	29%

Panel B. High Responsibility:

	Inexperienced n=7	*Experienced* n=14
Good Loan	100%	57%
Troubled Loan	0%	43%

The test of the research hypothesis is accomplished by testing for an interaction of personal responsibility, the loan evaluation judgment, and experience. A significant interaction indicates that the loan evaluation judgment is different for different combinations of the two explanatory variables, experience and personal responsibility. Analyses are performed on (1) the two-way interaction of the loan evaluation judgment and personal responsibility conditioned on each level of experience and (2) the two-way interaction for the loan evaluation judgment and experience conditioned on each level of personal responsibility. These analyses are used to specify the relation between each of the two explanatory variables, personal responsibility and experience, and the response variable, the loan evaluation judgment.

The null form of the hypothesis is that experience, personal responsibility, and the loan evaluation judgment are not related. The hypothesis of no relationship was rejected ($p<0.03$), and it is assumed that there is a significant interaction of personal responsibility, the loan evaluation judgment, and experience. That is, different loan evaluation judgments are made as the levels of personal responsibility and experience vary.

The significant interaction indicates a significant main effect of personal responsibility, a significant main effect of experience, and that the lower order two-way interactions are significant. The lower order two-way interaction between the loan evaluation judgment and experience was analyzed by using models conditioned on each level of personal responsibility; models for the loan evaluation judgment and experience were generated for each level of personal responsibility. The results are presented in table 1.

For the low personal responsibility condition, the hypothesis that experience and the loan evaluation judgment are independent cannot be rejected ($p=0.65$). For the high personal responsibility condition, however, the hypothesis of independence is rejected ($p=0.01$), and a relation between experience and judgment is assumed when a decision maker has high personal responsibility for the judgment. As shown in table 1, 38 percent of the inexperienced subjects and 29 percent of the experienced subjects

Table 2
Personal Responsibility by Loan Evaluation Judgment Conditioned by Experience

Panel A. Experienced:

	Low Responsibility n=13	*High Responsibility* n=7
Good Loan	62%	100%
Troubled Loan	38%	0%

Panel B. Inexperienced:

	Low Responsibility n=7	*High Responsibility* n=14
Good Loan	71%	57%
Troubled Loan	29%	43%

with low personal responsibility evaluated the loan as troubled. In other words, approximately the same proportion of inexperienced and experienced subjects evaluated the loan as troubled ($p=0.65$). This is in contrast to the results for high personal responsibility subjects, which show that none of the inexperienced subjects judged the loan to be troubled, although 43 percent of the experienced subjects did so. In the high personal responsibility condition, where the escalation bias is predicted to appear, inexperienced subjects evaluated the loan more favorably than experienced subjects ($p=0.01$).

The significant lower order two-way interaction between the loan evaluation judgment and personal responsibility was analyzed by using models conditioned on each level of experience, and these results appear in table 2. For the low experience condition, the hypothesis that the loan evaluation judgment and personal responsibility are independent is rejected ($p=0.02$); for inexperienced subjects, there is a significant interaction between these variables. For inexperienced auditors, 38 percent of those in the low personal responsibility condition evaluated the loan as troubled, but none in the high personal responsibility condition did so. This indicates escalation behavior in the loan evaluation judgments of the inexperienced subjects. In the high experience condition, however, the hypothesis that personal responsibility and the loan evaluation judgment are independent cannot be rejected ($p=0.5$); experienced subjects did not exhibit any escalation biases in their loan evaluation judgments.

III. Discussion and Conclusions

This research studied the loan evaluation judgments of auditors in a realistic professional setting and evaluated the influence of participation in sequential audits and experience in the loan evaluation environment on judgments. In particular, the results indicate that professional auditors may be susceptible to escalation behavior when making such judgments, but that experience may eliminate escalation behavior.

The experiment tested the importance of personal responsibility by considering the number of sequential judgments an auditor makes. Contingency table analysis with a loglinear model indicated a significant interaction between personal responsibility, experience, and the loan evaluation judgment. Inexperienced auditors making sequential decisions evaluated a deteriorating loan more favorably than did experienced auditors using identical information but making only a single judgment. In other words, inexperienced auditors exhibited escalation behavior in their loan evaluation judgments, but this effect was not apparent in the judgments of experienced auditors.

It is important to note that even though experience mitigates escalation behavior, overall only 38 percent of the experienced subjects and 25 percent of the inexperienced subjects evaluated the loan as troubled. A possible explanation for this result is that, although the case materials were designed to be very realistic and although subjects seemed to respond to the experimental task seriously, all the incentives for performance in a professional environment cannot be duplicated in an experiment. Because accountability is thought to encourage complexity of thought and improved judgments, the results may be biased against detecting the deterioration of the loan. Although the significant results indicate a strong relation among the loan evaluation judgment, personal responsibility for judgments, and experience, future research should attempt to discover reasons for the disparity in the judgments of the experienced auditors.

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SHORTER ARTICLES

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Accounting Recognition and the Relevance of Earnings as an Explanatory Variable for Returns

Terry D. Warfield
John J. Wild
University of Wisconsin–Madison

SYNOPSIS AND INTRODUCTION: The recognition of economic events in accounting earnings tends to lag that of the market. An informed market recognizes the effects of economic events when they occur, but earnings recognition must await compliance with formal accounting recognition criteria. The application of these criteria involves such basic concepts as reliability, objectivity, conservatism, and verifiability, and affects earnings in two ways: (1) *current* earnings will include recognition of certain *prior* periods' economic events, and (2) *current* earnings does *not* recognize all of the current period's economic events until *future* periods (see also Easton et al. 1992). Economic events for which accounting recognition tends to lag market recognition include purchase and sale commitments, contingencies, post-employment employee obligations, investments in human capital, and variations in the market values of assets and liabilities.

The purpose of this article is to investigate accounting recognition as a major determinant of earnings' explanatory power for returns. Our hypotheses are threefold. First, if accounting recognition lags that of the market, then its effect is predictably greater in shorter reporting periods. The shorter the reporting period, the lower the percentage of economic events recognized in *both* earnings and returns. For example, if all economic events that are immediately recognized in returns are recognized in earnings one quarter hence, then the current quarterly earnings' explanatory power would be zero, whereas annual earnings would reflect the

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recognition of three-fourths of all the economic events recognized in returns. Second, if the criteria for accounting recognition yield a multiperiod lag in earnings recognition of economic phenomena, then *future* periods' earnings possess explanatory power for current returns. A corollary hypothesis predicts that the incremental explanatory power of future periods' earnings varies inversely with the length of the reporting period. Third, if the influence of accounting recognition criteria for earnings measurement differs by companies' economic circumstances, then cross-sectional differences in these circumstances are predictably linked with earnings' explanatory power for returns. Economic circumstances that affect earnings recognition include companies' operating cycles, riskiness of cash flows, and the reliability, objectivity, availability, and verifiability of accounting and market data.

We document evidence consistent with a substantial lag in earnings recognition. Findings reveal an inverse relation between earnings' explanatory power for returns and the length of the reporting period, which is consistent with a lag in earnings recognition that deteriorates in longer reporting periods. Specifically, the explanatory power of earnings for returns in quarterly periods is about one-fourth that for semiannual periods, less than one-tenth that for annual periods, and less than one-thirtieth that for two-year periods. Moreover, the explanatory power of the regression (adjusted R^2) when using quarterly earnings is less than 1 percent, but exceeds 39 percent when using four-year earnings and returns. We attribute this phenomenon to accounting criteria that recognize economic events with a lag and to the disaggregation of earnings (through time), which accentuates this lag. Easton et al. (1992) offer some evidence consistent with the first hypothesis, but their evidence is limited to reporting periods of one to ten years in length. This is the first evidence we are aware of for reporting periods of less than one year.

We also present evidence that earnings lag current returns for several future periods. In certain instances, the recognition lag is of such magnitude that the explanatory power of future periods' earnings for current returns more than triples that of current earnings. For example, with quarterly reporting periods, the inclusion of future periods' quarterly earnings increases the adjusted R^2 of the returns-earnings relation by more than 400 percent. This evidence is consistent with a substantial lag in accounting recognition of economic events that spans a number of reporting periods. To the extent that accounting regulatory agencies want earnings to reflect current changes in the market values of companies, this evidence implies significant potential for enhancing earnings' usefulness.

Finally, we show that, when earnings measurements are less sensitive to accounting recognition criteria, earnings have greater explanatory power for returns. For example, with biennial reporting periods, current earnings' explanatory power for current returns exceeds 50 percent for companies whose earnings measurements are less sensitive to accounting recognition criteria, but is less than 20 percent for companies more sensitive to these criteria. This result is consistent with a joint relation between (1) the application of accounting principles in practice and (2) the explanatory

power of earnings for returns. Evidence of systematic cross-sectional differences in accounting recognition suggests that deliberations on accounting policy must consider characteristics of the reporting and operating environments; for example, the desire for verification, reliability, or conservatism might explain the accounting practices observed.

The evidence reported emphasizes the significant role that accounting recognition plays in determining earnings' explanatory power for returns. The evidence also relates the lag in accounting recognition of economic events to cross-sectional differences in fundamental economic determinants of earnings recognition. This evidence of a link between earnings' explanatory power and basic concepts of accounting recognition and measurement should encourage further efforts at mapping the complex accounting structure that determines the usefulness of earnings. In light of the Securities and Exchange Commission's recent emphasis on market-based measures of performance, which is referred to as "possibly the most significant initiative in accounting principles development in over 50 years" (Wyatt 1991, 80), our results highlight the potential for substantial improvement in earnings' explanatory power. Evidence on the reporting lag inherent in the application of accounting recognition criteria, and its cross-sectional determinants, is relevant for these policy deliberations.

Key Words: *Accounting recognition, Reporting interval, Earnings, Financial reporting.*

Data Availability: *Data in this study are taken from public sources.*

I. Recognition Practices and the Motivation for Empirical Tests

Accounting Recognition

ACCOUNTING recognition is "the process of formally recording or incorporating an item in the accounts and financial statements of an entity" (FASB 1980, SFAC No. 3, par. 83). The decision to recognize specific transactions and economic events in the accounts and financial statements depends on several interrelated "recognition and measurement concepts" (FASB 1984, SFAC No. 5), including reliability, objectivity, verifiability, realizability, matching, and conservatism. Because application of these concepts tends to delay recognition when there is uncertainty about either completion or measurement of transactions and events, earnings exhibit a recognition lag. This recognition lag is attributed, at least in part, to the application of generally accepted accounting principles. Both the application and consequences of accounting recognition concepts might be best depicted with several examples.

Our first example, accounting for contingencies, illustrates both the recognition lag in accounting earnings *and* the discrete nature of its measurement. Generally, contingencies are defined as economic events whose existence is uncertain (FASB 1975a, SFAS No. 5). In the case of loss contingencies, no expense is recorded unless the loss is both probable and the amount reasonably estimable, at which point an expense is recorded for the full amount. Consequently, earnings fails to recognize any part of the potential loss until its existence is likely. Gain contingencies, however, are rarely recognized prior to their resolution and are disclosed only when the probability is high that the gain will be realized (Deakin 1989).

Accounting recognition serves an important role for both short-term marketable securities (FASB 1975b, SFAS No. 12) and inventories (AICPA 1953, ARB No. 43) but entails, among other effects, a lag in earnings recognition. The accounting for both of these assets departs from the historical cost principle, but in a conservative manner. Specifically, the assets are recorded at historical cost unless their market values are lower than cost, in which case holding losses (and recoveries of previously recognized holding losses) are reflected in accounting earnings. However, holding gains (above historical cost) are not recorded for these assets until they are sold, so earnings recognition lags variations in market value.[1]

Accounting for long-term debt illustrates a lack of recognition of gains and losses from changes in money market conditions. Debt is initially recorded at a value indicative of current money market conditions, and subsequent interest costs reflect those original conditions. That is, if market conditions change such that a company is able to buy back its debt at prices below book value, this holding gain is not recorded unless the company actually extinguishes the debt. The same rules apply to holding losses.

Other economic events subject to a lag in accounting recognition include the effects from product changes, variations in input or output prices, legislative actions, and the loss or gain of important customers and suppliers. Moreover, companies' financial, operating, and investment activities, which exhibit similarities within industries, are predictably important factors in the application of recognition and measurement concepts in practice. In summary, this discussion illustrates the relevance (and limitations) of earnings recognition and measurement criteria for economic events. Our purpose is to demonstrate that all economic events are not recognized in earnings for the period in which they occur (nor in the period in which they are recognized in stock returns).

Concepts and Motivation for Empirical Tests

The effects of accounting recognition are manifest in the relation between accounting earnings and stock returns. Our discussion implies that earnings for longer reporting periods are less subject to the effects of recognition lag. This notion is apparent in the lifetime earnings of a company; accounting recognition plays no role when *all* valuation-relevant events are subsumed in lifetime earnings. Easton et al. (1992) employ this concept in tests of the returns-earnings relation as the reporting period extends from one to ten years. Predictably, as the length of the reporting period declines, the importance of accounting recognition rules for the relation between earnings and returns is magnified.

This discussion yields three hypotheses. First, if the percentage of valuation-relevant events recognized in earnings declines with the length of the reporting period, then the explanatory power of earnings for returns is predictably lower for interim periods compared to longer periods. Second, as the reporting period shortens, the percentage of the current period's valuation-relevant events recognized in future periods' earnings increases. Hence, we expect future periods' earnings to possess significant explanatory power for the current period's stock returns. Finally, we expect earnings' explanatory power to systematically differ across companies because of differential application of accounting recognition criteria.

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[1] These standards notwithstanding, there are inconsistent applications of accounting for investment securities across industries; e.g., see Wyatt (1991, 81).

II. Data and Sample Selection

Our sample of 24,150 company-quarter observations is drawn from the period 1983-86 and consists of companies that meet the following criteria: (1) earnings per share, earnings announcement dates, dividends, common stock prices, and adjustment factors (for stock splits and dividends) are available on the 1987 COMPUSTAT primary, secondary, tertiary and full coverage database; (2) daily adjusted stock returns (including dividends) are available from the 1988 *Center for Research in Security Prices* daily master file. All earnings, stock price, and return data are adjusted for stock splits and dividends. All companies with data available on both files, for each sample quarter, are candidates for the test sample. The minimum number of observations in any quarter is 1,409, and the maximum is 1,604.[2]

We choose to examine quarterly earnings for several reasons. First, for shorter reporting periods, it is less likely that earnings reflects a high proportion of economic events occurring in the same period. Since the proportion of economic events captured in quarterly earnings is arguably less than that for earnings measured over a year or longer, the generality of prior research to shorter periods is problematic. Second, the relevance of accrual accounting, which manifests itself in earnings, likely depends on the length of the reporting period. For example, the incremental contribution of reported earnings relative to net cash flows should be inversely related to the length of the reporting period (i.e., differences between earnings and net cash flows erode in longer periods). Third, since U.S. companies report earnings on an interim basis, questions concerning earnings' explanatory power are properly addressed by considering reporting periods of less than a year. Finally, since interim earnings aggregate over longer reporting periods, this design allows us to compare quarterly earnings' explanatory power for returns with that of semiannual, annual, biennial, and quadrennial aggregate earnings.

III. Accounting Recognition as a Determinant of Earnings' Explanatory Power

We estimate the following regression model to assess the significance of reported earnings as an explanatory variable for stock returns:[3]

$$R_{j,q}=\alpha_{q0}+\alpha_{q1}\bullet A_{j,q}/P_{j,q-1}+\epsilon_{j,q}, \qquad (1)$$

where $R_{j,q}$ is the stock return of firm j for the reporting period $q-1$ to q (adjusted for dividends), $P_{j,q}$ is the price per share of firm j at time q, and $A_{j,q}$ is accounting earnings per share of firm j for the reporting period $q-1$ to q.[4] Our first hypothesis predicts that, although earnings is significant in explaining returns (i.e., α_{q1} is positive), the explanatory power (adjusted R^2) is positively related to the length of the reporting period.

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[2] To be certain that our results are not unduly influenced by extreme values, we applied several different truncation rules to the data. This additional analysis yields inferences similar to those reported here.

[3] This specification is analogous to that proposed by Ohlson (1988, 1991), Easton and Harris (1991), and Easton et al. (1992). The interested reader is referred to these articles for further details.

[4] Stock returns correspond to the period between earnings announcements. The price per share of firm j at time q is the closing stock price for period q.

Table 1 presents the regression results for earnings and returns in quarterly periods. The evidence indicates that quarterly earnings is significant in explaining quarterly returns, but the explanatory power is low. Specifically, the results with all 24,150 firm-quarter observations yield an adjusted R^2 of 0.39 percent and an earnings coefficient ($\alpha_{q1}=0.08$) that is significant at the 0.001 level. The results from the cross-sectional regression model estimated by quarter yield similar inferences. In all but two quarters the relation between earnings and returns is significant (at the 0.01 level or better), but the adjusted R^2 values are again low and range from -0.05 percent to 9.75 percent.[5] Hence, although quarterly earnings do recognize some valuation-relevant events that are contemporaneously recognized in companies' stock returns, the low explanatory power is consistent with a substantial reporting lag from application of accounting recognition and measurement concepts.

If accounting recognition lag is a principal determinant of interim earnings' low explanatory power, then earnings' explanatory power should increase as the reporting period increases. To examine this hypothesis, we form four different reporting periods from the four-year sample period; specifically, we construct eight semiannual periods, four annual periods, two binennial periods, and one quadrennial period. Next, like Easton et al. (1992), we calculate aggregate measures of both returns and earnings for all companies and time periods.[6] We then regress returns on earnings, as in equation (1), for each of these four different reporting periods.

The regression results for alternative reporting periods are shown in table 2. Evidence from the eight semiannual periods in the four-year sample is presented in panel A. The pooled cross-sectional and time-series regression yields an adjusted R^2 of 1.78 percent, which represents a 350 percent increase in comparison with the adjusted R^2 for quarterly periods (0.39 percent). The average adjusted R^2 for the seminannual periods is 4.66 percent and ranges from a low of 0.06 percent to a high of 9.20 percent; in comparison, the average adjusted R^2 for the individual quarterly periods is 2.10 percent, with a low of -0.05 percent and a high of 9.75 percent. Hence, although earnings' explanatory power substantially increases for semiannual periods relative to quarterly periods, it remains low.

The results from the annual reporting periods are displayed in panel B of table 2. The adjusted R^2 for the pooled four-year sample is 5.55 percent; a 200 percent (1,300 percent) increase over that for the semiannual (quarterly) reporting periods. This increase is also evident in the individual annual adjusted R^2s, which average 9.01 percent, and range from a low of 2.62 percent to a high of 18.10 percent. The pooled regression for biennial periods yields an adjusted R^2 of 15.19 percent, and the adjusted R^2s for the two separate periods are 13.52 and 21.27 percent. The single quadrennial regression, reported in panel D, yields an adjusted R^2 of 39.76 percent, which is considerably larger than any obtained from the shorter reporting periods.

[5] Because of possible cross-sectional correlation in the regresssion error term of equation (1), there is the potential for bias in statistical inferences regarding the earnings coefficient (see Bernard 1987). Therefore, we employ an alternative procedure to test the significance of the earnings coefficient by using the mean and standard error of the coefficients obtained from the separate quarterly regressions (with the assumption that these quarterly regressions are independent). The coefficient estimate and *t*-value from this procedure are shown in the last line of table 1. The coefficient (0.31) is somewhat larger than that for the pooled sample (0.08) but conforms with the pooled-sample results and is significantly greater than zero (at the 0.001 level).

[6] Reporting period returns are measured with continuously compounded daily returns, beginning after the prior period's earnings announcement and ending on the date of the current period's earnings announcement. Reported earnings for the period are measured with quarterly earnings (appropriately summed for the length of the reporting period) divided by stock price at the beginning of the reporting period.

Table 1
Explanatory Power of Quarterly Earnings for Quarterly Returns
(Model:[a] $R_{j,q}=\alpha_{q0}+\alpha_{q1}\bullet A_{j,q}/P_{j,q-1}+\epsilon_{j,q}$)

Year : Quarter	$\hat{\alpha}_{q0}$	$\hat{\alpha}_{q1}$	Adjusted R² (%)	Sample Size
All Periods	0.04 (39.0)	0.08 (9.8)	0.39	24,150
1986 : IV	0.11 (20.8)	−0.01 (−0.5)	−0.05	1,602
1986 : III	0.02 (4.1)	0.09 (3.5)	0.68	1,604
1986 : II	0.01 (1.4)	0.27 (6.9)	2.82	1,593
1986 : I	0.09 (21.2)	0.03 (1.8)	0.15	1,579
1985 : IV	0.10 (20.3)	0.12 (5.3)	1.70	1,568
1985 : III	−0.00 (−0.4)	0.19 (5.2)	1.68	1,552
1985 : II	0.05 (12.5)	0.42 (6.4)	2.55	1,530
1985 : I	0.02 (5.7)	0.46 (6.9)	2.97	1,512
1984 : IV	0.09 (19.6)	0.12 (4.2)	1.10	1,490
1984 : III	0.03 (7.0)	1.14 (12.7)	9.75	1,497
1984 : II	−0.04 (−9.1)	0.49 (6.8)	2.97	1,483
1984 : I	−0.02 (−5.4)	0.68 (6.9)	3.13	1,461
1983 : IV	−0.02 (−6.4)	0.11 (2.2)	0.26	1,425
1983 : III	0.01 (1.4)	0.63 (7.2)	3.48	1,424
1983 : II	0.08 (17.1)	0.18 (2.4)	0.32	1,421
1983 : I	0.13 (26.0)	0.06 (1.1)	0.01	1,409
Average[b]		0.31 (4.0)	2.10	

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[a] Stock returns ($R_{j,q}$) are measured from after the prior period's earnings announcement through the current period's announcement; $A_{j,q}$ is reported earnings per share, and $P_{j,q-1}$ is the price per share of company j at time $q-1$. Parameter estimates and t-statistics (in parentheses) are presented for each regression. The sample comprises company-quarter observations from the first quarter of 1983 through the fourth quarter of 1986.

[b] These statistics represent the average quarterly parameter estimate and t-statistic. These figures are computed to examine for the effect of cross-sectional correlations in the regression's error terms.

Table 2

Explanatory Power of Earnings for Returns under Alternative Reporting Periods

(*Model:*[a] $R_{j,q}=\alpha_{q0}+\alpha_{q1}\bullet A_{j,q}/P_{j,q-1}+\epsilon_{j,q}$)

Panel A. Returns and Earnings Measured over Semiannual Reporting Periods:

Reporting Period	$\hat{\alpha}_{q0}$	$\hat{\alpha}_{q1}$	Adjusted R^2 (%)	Sample Size
All Periods	0.09 (37.3)	0.20 (14.8)	1.78	11,962
1986 : II	0.12 (17.8)	0.06 (2.5)	0.32	1,604
1986 : I	0.09 (14.2)	0.41 (9.4)	5.33	1,560
1985 : II	0.10 (15.1)	0.21 (8.2)	4.12	1,547
1985 : I	0.06 (11.9)	0.71 (12.4)	9.20	1,503
1984 : II	0.13 (21.0)	0.43 (10.6)	7.07	1,472
1984 : I	−0.07 (−11.8)	0.81 (11.1)	7.74	1,450
1983 : II	−0.02 (−3.2)	0.44 (7.2)	3.44	1,423
1983 : I	0.24 (27.7)	0.08 (1.4)	0.06	1,403
Average[b]		0.39 (4.0)	4.66	

Panel B. Returns and Earnings Measured over Annual Reporting Periods:

Reporting Period	$\hat{\alpha}_{q0}$	$\hat{\alpha}_{q1}$	Adjusted R^2 (%)	Sample Size
All Periods	0.18 (33.2)	0.38 (18.3)	5.55	5,714
1986	0.23 (21.0)	0.25 (7.7)	3.76	1,502
1985	0.17 (18.8)	0.51 (13.8)	11.57	1,451
1984	0.05 (5.8)	0.89 (17.6)	18.10	1,398
1983	0.22 (16.6)	0.33 (6.1)	2.62	1,363
Average[b]		0.50 (3.5)	9.01	

(*Continued*)

Table 2—*Continued*

Explanatory Power of Earnings for Returns under Alternative Reporting Periods

(*Model:*[a] $R_{j,q}=\alpha_{q0}+\alpha_{q1}\bullet A_{j,q}/P_{j,q-1}+\epsilon_{j,q}$)

Panel C. Returns and Earnings Measured over Biennial Reporting Periods:

Reporting Period	$\hat{\alpha}_{q0}$	$\hat{\alpha}_{q1}$	*Adjusted* R² (%)	*Sample Size*
All Periods	0.34 (27.2)	0.67 (21.8)	15.19	2,640
1985–1986	0.44 (22.9)	0.66 (14.5)	13.52	1,347
1983–1984	0.23 (14.9)	0.74 (18.7)	21.27	1,293
Average[b]		0.70 (18.9)	17.40	

Panel D. Returns and Earnings Measured over the Quadrennial Reporting Period:

Reporting Period	$\hat{\alpha}_{q0}$	$\hat{\alpha}_{q1}$	*Adjusted* R² (%)	*Sample Size*
1983–1986	0.62 (16.7)	1.30 (27.4)	39.76	1,135

[a] Stock returns ($R_{j,q}$) are measured for the reporting period beginning after the prior reporting period's earnings announcement and ending with the current period's announcement; $A_{j,q}$ is the aggregate earnings per share for the reporting period, and $P_{j,q-1}$ is the price per share of company j at time $q-1$ (beginning of the reporting period). Parameter estimates and t-statistics (in parentheses) are presented for each regression. The reporting periods cover the years 1983–1986.

[b] These statistics represent the reporting periods' average parameter estimate and t-statistic. These figures are computed to examine for the effect of cross-sectional correlations in the regression's error terms.

In summary, this evidence of low correlation between earnings and returns in shorter reporting periods is consistent with a substantial lag in accounting recognition of economic events in interim earnings. This inference is bolstered by the monotonically increasing explanatory power of earnings for returns as the reporting period expands from quarterly to seminannual, annual, biennial, and finally quadrennial periods. In the next section we examine the extent of the recognition lag in earnings for current stock returns, and investigate accounting factors underlying this phenomenon.

IV. The Extent and Determinants of Earnings Recognition Lag

Extent of Earnings Recognition Lag

The purpose of this section is to examine the extent to which earnings recognition of economic events lags that of the market as this is reflected in future earnings' explanatory power for current period returns. Our premise regarding the application of accounting recognition concepts is that earnings contains both value-*relevant* and value-*irrelevant* information for explaining current returns, and the value-irrelevant component consists of information that was recognized in prior periods' returns.[7] In conformance with this premise, the relative significance of these two components is predictably a function of the length of the reporting period *and* accounting recognition practices (the latter factor is considered in the next section). We hypothesize that, if earnings recognition lags that of the market, then (1) future earnings are correlated with current returns and (2) the explanatory power of future earnings for current returns varies inversely with the length of the reporting period. The latter follows from our conjecture that the longer the reporting period, the larger the proportion of economic events recognized in both earnings and returns for the same period. Evidence of a significant relation between current returns and future earnings reflects on timeliness, or lack thereof, for reported earnings' ability to track current period changes in company values.

We estimate the following regression model to assess the relation between current returns and both current and future periods' earnings:

$$\begin{aligned} R_{j,q} = {} & \gamma_{q0} + \gamma_{q1} \bullet A_{j,q}/P_{j,q-1} + \gamma_{q2} \bullet A_{j,q+1}/P_{j,q-1} + \gamma_{q3} \bullet A_{j,q+2}/P_{j,q-1} \\ & + \gamma_{q4} \bullet A_{j,q+3}/P_{j,q-1} + \gamma_{q5} \bullet A_{j,q+4}/P_{j,q-1} + \epsilon_{j,q}, \end{aligned} \tag{2}$$

where the variables are defined as in equation (1). Consistent with our hypothesis, we expect future periods' earnings to possess explanatory power for current returns (i.e., the γ_{q2} through γ_{q5} parameters are positive and significant).[8]

The regression results for quarterly reporting periods, shown in table 3, are consistent with a substantial lag in the recognition of economic events in earnings. The parameter estimates on future quarterly earnings from the pooled sample are positive and significant for all four quarters (i.e., γ_{q2}, γ_{q3}, γ_{q4}, and γ_{q5} equal 0.120, 0.091, 0.086,and 0.054, respectively). The adjusted R^2 of 1.95 percent is still low, but reflects a 400 percent increase in explanatory power when compared with current earnings as the sole explanatory variable (0.39 percent). Similarly, a simple average of the adjusted R^2s of all 16 quarterly regressions is 4.93 percent, in comparison with 2.10 percent for a simple average of the 16 contemporaneous returns-earnings regressions in table 1.[9]

To assess the incremental contribution of future periods' earnings in explaining current returns (i.e., the extent of the lag in earnings recognition), we regress current returns on both current earnings and successive combinations of future periods' earnings: (1) current and next period's earnings, (2) current and the next two periods' earnings, (3) current and the next three periods' earnings, and (4) current and the next four periods' earnings. The adjusted R^2s from these regressions, shown in the first row of table 4, are 0.39, 1.26, 1.62, 1.85, and 1.95 percent, respectively. Notice the logarithmic-type pattern in adjusted R^2s as future periods' earnings are successively added to the regression; adjusted R^2 increases substantially (223 percent) when the immediate future period's earnings is added, but only minimally (5 percent) with the inclusion of

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[7] Prior research (Beaver et al. 1980) shows that prices lead earnings in annual periods. The market obtains information about economic events from many different sources, including footnote and nonearnings disclosures in companies' financial reports (Ou and Penman 1989a, 1989b).

[8] It is reasonable to expect the explanatory power of future earnings for current returns to be immaterial (in the limit) for more distant future periods' earnings (also, see fn. 10).

[9] As was done for the "average coefficient" test in table 1, we compute the mean and standard error of the parameter estimates from the individual quarterly regressions. The resulting estimates, shown at the bottom of table 3, support the pooled sample results in that future periods' reported earnings are significantly associated with current returns.

Table 3

Explanatory Power of Current and Future Quarterly Earnings for Current Quarterly Returns

(*Model:*[a] $R_{j,q}=\gamma_{q0}+\gamma_{q1}\bullet A_{j,q}/P_{j,q-1}+\gamma_{q2}\bullet A_{j,q+1}/P_{j,q-1}+\gamma_{q3}\bullet A_{j,q+2}/P_{j,q-1}$
$+\gamma_{q4}\bullet A_{j,q+3}/P_{j,q-1}+\gamma_{q5}\bullet A_{j,q+4}/P_{j,q-1}+\epsilon_{j,q}$)

Year : Quarter	γ_{q0}	γ_{q1}	γ_{q2}	γ_{q3}	γ_{q4}	γ_{q5}	*Adjusted R² (%)*	*Sample Size*
All Periods	0.04	0.02	0.12	0.09	0.09	0.05	1.95	24,150
	(36.2)	(2.6)	(10.4)	(7.1)	(6.9)	(5.1)		
1986 : IV	0.10	0.01	−0.15	−0.06	0.27	−0.02	0.37	1,602
	(20.2)	(0.4)	(−1.6)	(−1.1)	(2.9)	(−1.2)		
1986 : III	0.02	0.04	0.05	0.05	−0.02	0.31	1.84	1,604
	(3.4)	(1.4)	(2.5)	(0.5)	(−0.4)	(3.5)		
1986 : II	0.01	0.14	0.04	0.12	−0.04	0.19	5.17	1,593
	(1.6)	(2.8)	(0.8)	(4.7)	(−0.4)	(3.2)		
1986 : I	0.08	0.02	0.01	−0.03	0.11	0.25	2.26	1,579
	(20.3)	(1.1)	(0.2)	(−0.7)	(4.6)	(3.1)		
1985 : IV	0.09	0.08	0.32	−0.01	0.13	0.03	4.88	1,568
	(19.7)	(3.3)	(5.8)	(−0.2)	(3.0)	(1.1)		
1985 : III	−0.00	0.02	0.12	0.22	0.04	0.20	7.00	1,552
	(−0.9)	(0.5)	(4.6)	(3.7)	(1.0)	(4.8)		
1985 : II	0.05	0.42	−0.04	0.04	−0.19	−0.00	3.27	1,530
	(12.9)	(5.4)	(−0.6)	(1.3)	(−3.7)	(−0.1)		
1985 : I	0.02	0.40	0.27	0.24	0.00	−0.03	5.86	1,512
	(4.0)	(4.2)	(4.3)	(3.6)	(0.1)	(−0.7)		
1984 : IV	0.08	0.16	−0.24	0.47	0.29	−0.09	3.76	1,490
	(16.5)	(4.7)	(−2.0)	(5.5)	(3.2)	(−2.4)		
1984 : III	0.02	0.81	0.03	0.49	0.22	0.06	12.60	1,497
	(5.4)	(7.3)	(0.8)	(4.9)	(2.7)	(0.9)		
1984 : II	−0.05	0.18	0.70	0.12	0.05	0.29	9.06	1,483
	(−11.3)	(2.3)	(6.1)	(2.6)	(0.5)	(3.2)		
1984 : I	−0.02	0.56	0.14	0.16	−0.02	0.03	3.36	1,461
	(−5.9)	(4.6)	(1.9)	(1.5)	(−0.4)	(0.3)		
1983 : IV	−0.04	−0.05	0.52	0.20	0.25	0.05	2.75	1,425
	(−8.5)	(−0.9)	(3.7)	(2.2)	(1.9)	(0.8)		
1983 : III	−0.02	0.25	0.04	0.84	0.30	0.60	9.56	1,424
	(−4.1)	(2.5)	(0.5)	(5.3)	(2.9)	(4.1)		
1983 : II	0.08	0.15	−0.02	−0.09	0.01	0.33	0.91	1,421
	(13.6)	(1.7)	(−0.2)	(−1.2)	(0.0)	(3.3)		
1983 : I	0.11	−0.14	−0.11	0.20	0.12	0.94	6.16	1,409
	(19.0)	(−2.4)	(−1.2)	(2.1)	(1.7)	(7.5)		
Average[b]		0.19	0.11	0.18	0.10	0.20	4.93	
		(3.1)	(1.7)	(3.1)	(2.7)	(2.9)		

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[a] Stock returns ($R_{j,q}$) are measured from immediately after the prior period's earnings announcement through the current period's announcement; $A_{j,q}$ is reported earnings per share for time period q, and $P_{j,q-1}$ is the price per share of company j at time $q-1$. Parameter estimates and t-statistics (in parentheses) are presented for each regression. The sample comprises company-quarter observations from the first quarter of 1983 through the fourth quarter of 1986.

[b] These statistics represent the average quarterly parameter estimate and t-statistic. These figures are computed to examine for the effect of cross-sectional correlations in the regression's error terms.

Table 4

Current and Future Earnings' Incremental Explanatory Power for Current Returns under Alternative Reporting Periods

(*General Model:*[a] $R_{j,q}=\gamma_{q0}+\gamma_{q1}\bullet A_{j,q}/P_{j,q-1}+\gamma_{q2}\bullet A_{j,q+1}/P_{j,q-1}+\gamma_{q3}\bullet A_{j,q+2}/P_{j,q-1}+\gamma_{q4}\bullet A_{j,q+3}/P_{j,q-1}+\gamma_{q5}\bullet A_{j,q+4}/P_{j,q-1}+\epsilon_{j,q}$)

	Alternative Combinations of Explanatory Variables				
Reporting Period	*Current Period's Earnings*	*Current and Next Period's Earnings*	*Current and Next Two Periods' Earnings*	*Current and Next Three Periods' Earnings*	*Current and Next Four Periods' Earnings*
Quarterly (n=24,150)					
Adjusted $R^2\%$[b]	0.39	1.26	1.62	1.85	1.95
Percentage Increase[c]	—	223	29	14	5
Semiannual (n=8,544)					
Adjusted $R^2\%$	2.44	4.41	5.37	6.38	6.60
Percentage Increase	—	81	22	19	3
Annual (n=2,650)					
Adjusted $R^2\%$	5.41	15.71	16.20	17.00	
Percentage Increase	—	190	3	5	
Biennial (n=1,285)					
Adjusted $R^2\%$	21.21	29.28			
Percentage Increase	—	38			

[a] Stock returns ($R_{j,q}$) are measured from immediately after the prior period's earnings announcement through the current period's announcement; $A_{j,q}$ is reported earnings per share for time period q, and $P_{j,q-1}$ is the price per share of company j at time q−1. The number of future periods' earnings in a regression is specified in the respective column heading; the maximum number of future periods' earnings in any model is four. The sample comprises company-period observations from 1983 through 1986.

[b] The adjusted R^2 is taken from the regression of the current period's returns on current period's earnings and successive combinations of future periods' earnings (the latter ranging from zero to four future periods).

[c] The percentage increase is computed by subtracting 1.0 from the ratio of adjusted R^2 for that column's regression model divided by the adjusted R^2 from the immediate left column's regression model.

four-period-ahead earnings.[10] Hence, although quarterly earnings substantially lag quarterly returns, the earnings recognition lag considerably diminishes after three or four quarters.[11]

To test the second part of our hypothesis, that the explanatory power varies inversely with the reporting period, we examine earnings recognition lag conditional on the length of the reporting period. We hypothesize that the incremental contribution of future earnings in explaining returns decreases with longer reporting periods if accounting recognition rules are a major determinant of the proportion of value-relevant events recognized in current earnings. Evidence is obtained through estimation of equation (2) for semiannual, annual, and biennial reporting periods. Summary results of these regression tests are displayed in table 4. For each reporting period, we show different regressions' adjusted R^2s along with the percentage incremental increase in explanatory power with successive inclusion of future earnings as a determinant of returns. The evidence indicates that the inclusion of the immediate next period's earnings increases the regression's explanatory power by 223, 81, 190, and 38 percent for quarterly, semiannual, annual, and biennial reporting periods, respectively (see second column of table 4). While increases in explanatory power are also evident with the inclusion of higher-order future earnings, the percentage increment is progressively less; for example, the inclusion of two (three) periods ahead earnings increases explanatory power by 29, 22, and 3 percent (14, 19, and 5 percent), respectively. The diminishing incremental explanatory power of future earnings for current returns as the reporting period increases is consistent with the hypothesis that the application of accounting recognition criteria is an important determinant of earnings' explanatory power, particularly for shorter reporting periods.

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[10] We also performed a regression of current quarter returns on the current and 12 future quarter earnings. The explanatory power of future earnings for current returns peaks at one or two quarters out and then gradually diminishes to zero; in particular, each of the first six future periods' quarterly earnings is statistically significant, but only one of the next six future periods' earnings is significant.

[11] An alternative explanation for a relation between current returns and future earnings is that the latter proxies for earnings expectations; however, we know of no hypothesis (other than the one we postulate) that predicts higher explanatory power for future earnings relative to current earnings, as shown here. Moreover, variation in future earnings' explanatory power by industry groups (presented in the next section) further reduces the likelihood of competing explanations for the results.

Accounting Determinants of Earnings Recognition Lag

Accounting recognition concepts are unimportant in the measurement of lifetime earnings (see sec. I), because, in the limit, earnings, cash flows, and returns are equivalent. However, current institutional arrangements in the United States require earnings reports for interim (e.g., quarterly) periods *and* compliance with generally accepted accounting principles. These requirements create fundamental problems for income recognition.

Accounting theory dictates that (1) revenue is recognized when goods or services are provided *and* when the asset earned is measurable with reasonable precision and objectivity (see FASB 1984, SFAC No. 5), and (2) expense recognition mirrors revenue recognition in that the expense associated with revenue activity is recognized (matched) in the same period as revenue. Consequently, consideration of earnings recognition depends on the practical application of diverse and sometimes conflicting accounting concepts, which include reliability, relevance, objectivity, verifiability, timeliness, and conservatism. Resolution in the application of these concepts to earnings recognition depends on a company's operating environment. For example, earnings recognition concepts are less likely to affect the earnings measurements for retail food companies in comparison with long-term construction firms because of differences in operating cycles, riskiness of receipts, reliability of data, and availability of objective and verifiable market prices. In large measure, the determinants of earnings recognition are a function of the industry (environment) in which the company operates.

The notion of industry-determined application of recognition concepts motivates us to explore the lag in accounting recognition of earnings for different industries. Specifically, we separate companies into three broad industry classes to capture variation in the application of recognition concepts and its effects on earnings measurement. The objective is to identify industry classes in which earnings recognition concepts play varying roles. As such, we construct three industry classes: mining, construction, and manufacturing, SIC code industries 1, 2, and 3; finance, insurance, real estate, public utilities, and transportation, SIC code industries 4 and 6; and wholesale-retail trade, and services, SIC code industries 5, 7, and 8. In light of our discussion of the determinants of accounting recognition, we expect earnings recognition lag to be greatest for the mining, construction, and manufacturing class, least for the wholesale-retail trade, and services class, and somewhere in between for the finance, insurance, real estate, public utilities, and transportation class.[12] For example, relative to the others, the wholesale-retail trade, and services companies possess shorter operating cycles (on average), and have more objective and verifiable input and output prices, which facilitate timely recognition of earnings.

We hypothesize that earnings from companies whose earnings measurements are less sensitive to accounting recognition criteria possess greater explanatory power for returns, *ceteris paribus*; an ancillary hypothesis predicts that this phenomenon extends to all reporting periods (e.g., quarterly, semiannual, annual, biennial). We also hypothesize that the incremental explanatory power from successive inclusion of future periods' earnings for returns is greater for companies whose earnings measurements are more sensitive to accounting recognition criteria.

The adjusted R^2s from regressions with successive combinations of future earnings (analogous to the tests in table 4), including results from increasingly longer reporting periods, are shown in table 5 for the three industry classes. Consistent with the first hypothesis, earnings possess greater explanatory power when accounting recognition criteria are predictably less important for earnings measurement. Results for the *contemporaneous* returns-earnings relation (first three columns of table 5) show that the adjusted R^2 is substantially higher for the industry class less sensitive to recognition rules (wholesale-retail trade, and services). For example, the quarterly regression's adjusted R^2 from the least sensitive group is 2.29 percent, compared to 0.30 percent for the most sensitive group and 0.20 percent for the intermediate group. The biennial period results are even more striking; the adjusted R^2 for the least sensitive group is 51.33 percent, compared to 17.59 percent for the most sensitive group and 14.49 percent for the intermediate group; keep in mind that this regression includes only contemporaneous earnings and returns.[13] These results are consistent with the hypothesis that the application of accounting recognition criteria is a major determinant of earnings' explanatory power for returns.

Evidence bearing on our second hypothesis (i.e., the incremental explanatory power from successive inclusion of future periods' earnings is higher for companies whose earnings measurements are more sensitive to recognition rules) is obtained from four separate analyses conducted for each industry group. Current returns are regressed on (1) current and next period's earnings, (2) current and the next two periods' earnings, (3) current and the next three periods' earnings, and (4) current and the next four periods' earnings. The adjusted R^2 for each of these regressions, presented by industry group, are displayed in columns four through fifteen of table 5. Notice that the rate of change in adjusted R^2 exhibits a logarithmic-type pattern within each group (similar to that in table 4 for the total sample). For example, for the group least sensitive to recognition rules, the adjusted R^2s equal 2.29, 3.44, 4.21, 4.25, and 4.73 percent with the successive addition of future quarterly earnings. This pattern is consistent with a

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[12] In addition to the arguments advanced, the finance, insurance, real estate, public utilities, and transportation group merits separate consideration because of the special regulatory environments in which these companies operate.

[13] Although not reported, a pattern similar to that observed with the regressions' adjusted R^2s is evident in the regressions' earnings coefficients—across industry classes and reporting periods.

Table 5

Current and Future Earnings' Incremental Explanatory Power for Current Returns Conditional on Company Groupings by Sensitivity to Accounting Recognition Criteria

(*General Model:*[a] $R_{j,q}=\gamma_{q0}+\gamma_{q1}\bullet A_{j,q}/P_{j,q-1}+\gamma_{q2}\bullet A_{j,q+1}/P_{j,q-1}+\gamma_{q3}\bullet A_{j,q+2}/P_{j,q-1}+\gamma_{q4}\bullet A_{j,q+3}/P_{j,q-1}+\gamma_{q5}\bullet A_{j,q+4}/P_{j,q-1}+\epsilon_{j,q}$)

	Alternative Combinations of Explanatory Variables														
	Current Period's Earnings			*Current and Next Period's Earnings*			*Current and Next Two Periods' Earnings*			*Current and Next Three Periods' Earnings*			*Current and Next Four Periods' Earnings*		
Reporting Period	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*	*High*	*Middle*	*Low*
Quarterly															
Adjusted R^2%[b]	0.30	0.20	2.29	1.30	0.72	3.44	1.61	1.10	4.21	1.76	2.24	4.25	1.81	2.28	4.73
Percentage Increase[c]	—	—	—	333	260	50	24	53	22	9	104	1	3	2	11
Semiannual															
Adjusted R^2%	1.57	3.20	8.42	3.83	4.86	10.84	4.89	5.12	13.12	6.61	5.18	13.22	6.76	5.43	13.16
Percentage Increase	—	—	—	144	52	29	28	5	21	35	1	1	2	5	0
Annual															
Adjusted R^2%	3.78	5.77	21.63	16.40	8.83	25.99	16.92	10.59	25.82	18.11	10.72	25.87			
Percentage Increase	—	—	—	334	53	20	3	20	−1	7	1	0			
Biennial															
Adjusted R^2%	17.59	14.49	51.33	28.33	19.14	53.81									
Percentage Increase	—	—	—	61	32	5									

[a] Stock returns ($R_{j,q}$) are measured from immediately after the prior period's earnings announcement through the current period's announcement; $A_{j,q}$ is reported earnings per share for time period q, and $P_{j,q-1}$ is the price per share of company j at time $q-1$. The number of future periods' earnings in a regression is specified in the respective column heading; the maximum number of future periods' earnings in any model is four. The sample comprises company-period observations from 1983 through 1986. Company groupings are conditional on an ex *ante* assessment of earning measurement sensitivity to recognition criteria: specifically, high sensitivity companies are from mining, construction, and manufacturing (SIC code industries 1, 2, and 3); companies comprising an intermediate (middle) group are from finance, insurance, real estate, public utilities, and transportation (SIC code industries 4 and 6); and low sensitivity companies are from wholesale-retail trade and services (SIC code industries 5, 7, and 8). The sample sizes for the High, Middle, and Low company groupings, in order and by reporting period, are: quarterly: 13,952, 6,253, and 3,945; semiannual: 5,012, 2,176, and 1,356; annual: 1,588, 647, and 415; and biennial: 780, 307, and 198.

[b] The adjusted R^2 is taken from the regression of the current period's returns on current period's earnings and successive combinations of future periods' earnings (the latter ranging from zero to four future periods).

[c] The percentage increase is computed by subtracting 1.0 from the ratio of adjusted R^2 for that group's regression model divided by the adjusted R^2 from the same group's regression model with one less explanatory variable,

recognition lag in earnings, but one whose impact steadily declines; for example, the percentage increases in adjusted R^2 for the group least sensitive to recognition rules from successive future quarterly earnings are 50, 22, 1, and 11 percent, respectively.

Also relevant to the second hypothesis is the extent of earnings recognition lag and its rate of decline for the different industry groups. The results show that the rate of change in adjusted R^2 from successive inclusion of future earnings is much greater for companies whose earnings measurements are more sensitive to recognition rules. For example, the increases in adjusted R^2 from successive inclusion of future quarterly earnings for the most sensitive group (intermediate group) are 333, 24, 9, and 3 percent (260, 53, 104, and 2 percent), respectively, which are generally larger than those of companies least sensitive to recognition rules (50, 22, 1, and 11 percent). This is also evident in the rate of change statistics for adjusted R^2 with semiannual, annual, and biennial reporting periods. For example, with annual periods, the increases in adjusted R^2 from successive inclusion of future earnings for the most sensitive group (intermediate group) are 334, 3, and 7 percent (53, 20, and 1 percent), respectively, but equal 20, −1, and 0 percent for companies least sensitive to recognition criteria.[14]

In summary, these findings document a substantial earnings recognition lag and, more importantly, highlight cross-sectional differences in the extent of this lag. We attribute these differences in lag to fundamental cross-sectional differences in the application of accounting recognition criteria at the company level, which affect earnings' explanatory power for returns.

V. Additional Evidence on Earnings Recognition Lag

Current Earnings Recognition of Prior Periods' Economic Events

The delay in accounting recognition of economic phenomena affects earnings in two ways: (1) earnings recognizes the effects of certain *prior* periods' economic events in the *current* period and (2) earnings does *not* recognize the effects of all contemporaneous economic events until *future* periods. The empirical analysis so far has concerned the second issue, primarily in light of our interest in understanding the extent, pattern, and determinants of the delay in earnings recognition as it affects earnings' ability to track changes in company value. However, interest in the extent to which returns recognize economic events in advance of earnings suggests an alternative test. Specifically, holding the reporting period constant, we regress current earnings on both current returns and successive combinations of *prior* periods' returns to obtain evidence on the extent to which earnings recognizes the effects of prior periods' economic events in the current period. In particular, current earnings are regressed on (1) current returns, (2) current and prior period's returns, (3) current and prior two periods' returns, (4) current and prior three periods' returns, and (5) current and prior four periods' returns. The results of these regressions for quarterly, semiannual, and annual reporting periods are shown in table 6, and corroborate earlier evidence of a substantial earnings lag.

Future Earnings Recognition of Current and Prior Periods' Economic Events

The evidence (in table 6) that earnings recognizes events impounded in current and prior periods' returns suggests that a regression of current returns on current and

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[14] A similar pattern is evident in the regressions' coefficients on current and future earnings for industry classes and reporting periods.

Table 6

Recognition of Current and Prior Periods' Economic Events in Current Earnings

(*General Model:*[a] $A_{j,q}/P_{j,q-k}=\phi_{q0}+\phi_{q1}\bullet R_{j,q}+\phi_{q2}\bullet R_{j,q-1}+\phi_{q3}\bullet R_{j,q-2}+\phi_{q4}\bullet R_{j,q-3}+\phi_{q5}\bullet R_{j,q-4}+\epsilon_{j,q}$)

	Alternative Combinations of Explanatory Variables				
Reporting Period	*Current Period's Returns*	*Current and Prior Period's Returns*	*Current and Prior Two Periods' Returns*	*Current and Prior Three Periods' Returns*	*Current and Prior Four Periods' Returns*
Quarterly ($n=12{,}507$)					
Adjusted R^2%[b]	0.67	2.55	4.05	4.36	5.17
Percentage Increase[c]	—	*281*	*59*	*8*	*19*
Semiannual ($n=5{,}220$)					
Adjusted R^2%	5.69	10.54	16.80		
Percentage Increase	—	*85*	*59*		
Annual ($n=2{,}535$)					
Adjusted R^2%	12.98	28.75			
Percentage Increase	—	*121*			

[a] $A_{j,q}$ is reported earnings per share of company j for time period q; $P_{j,q-k}$ is the price per share at time $q-k$ (where k is the number of explanatory variables in the model), and stock return ($R_{j,q}$) is measured from immediately after the prior period's earnings announcement through the current period's announcement for time period q. The number of successive prior periods' returns in a regression is specified in the column heading; the maximum number of prior periods' returns in any model is four. The sample comprises company-period observations from 1983 through 1986.

[b] The adjusted R^2 is taken from the regression of the current period's earnings (scaled by price at the beginning of the earliest return period) on current period's returns and successive combinations of prior periods' returns (the latter ranging from zero to four prior periods).

[c] The percentage increase is computed by subtracting 1.0 from the ratio of adjusted R^2 for that column's regression model divided by the adjusted R^2 from the immediate left column's regression model.

future periods' earnings is potentially contaminated by noise in the dependent variable since returns are measured only over the current reporting period. Consequently, to better control for this potential source of noise, we re-compute returns over various successive combinations of current *and* prior reporting periods. The alternative periods of return measurement include the (1) current period, (2) current and prior period, (3) current and two prior periods, (4) current and three prior periods, and (5) current and four prior periods. Returns measured over these various periods are then regressed on (1) current earnings, (2) current and next period's earnings, (3) current and the next two periods' earnings, (4) current and the next three periods' earnings, and (5) current and the next four periods' earnings. If there is a substantial recognition lag in earnings, then the inclusion of future periods' earnings in these regressions should be significant, in spite of including prior periods' returns in the dependent variable.

The results of these regressions, as summarized in the adjusted R^2-statistic, are shown in table 7. Notice that for each comparison (i.e., within-return measurement periods as reported across each row) the results indicate that future earnings continue to explain a significant portion of returns beyond that explained by current earnings.

Table 7

Current and Future Earnings' Incremental Explanatory Power for Returns Measured over Current and Prior Periods

(*General Model:*[a] $R_{j,[q-k,q]}=\gamma_{q0}+\gamma_{q1}\bullet A_{j,q}/P_{j,q-1}+\gamma_{q2}\bullet A_{j,q+1}/P_{j,q-1}+\gamma_{q3}\bullet A_{j,q+2}/P_{j,q-1}$
$+\gamma_{q4}\bullet A_{j,q+3}/P_{j,q-1}+\gamma_{q5}\bullet A_{j,q+4}/P_{j,q-1}+\epsilon_{j,q}$)

	Adjusted R^2 *for Alternative Combinations of Explanatory Variables*[b]				
Earnings Reporting Period	*Current Period's Earnings*	*Current and Next Period's Earnings*	*Current and Next Two Periods' Earnings*	*Current and Next Three Periods' Earnings*	*Current and Next Four Periods' Earnings*
Quarterly (n = 12,507)					
Return Measurement Period:					
Current Period	0.35	1.29	1.44	1.89	1.94
Current and One Prior	2.19	4.11	4.30	5.54	5.72
Current and Two Prior	4.28	6.20	7.05	9.42	9.74
Current and Three Prior	3.88	6.22	8.64	10.73	10.94
Current and Four Prior	4.47	8.05	11.95	13.19	13.38
Semiannual (n = 5,220)					
Return Measurement Period:					
Current Period	5.23	7.60	8.31	9.06	9.09
Current and One Prior	13.21	16.52	18.29	19.13	19.29
Annual (n = 2,535)					
Return Measurement Period:					
Current Period	11.56	16.03	16.87		
Current and One Prior	27.20	32.34	32.66		

[a] Stock returns ($R_{j,[q-k,q]}$) are measured from immediately after the earnings announcement for period $[(q-k)-1]$ through the current period q's announcement; $A_{j,q}$ is reported earnings per share for time period q_1, and $P_{j,q}$ is the price per share of company j at time q. The number of future periods' earnings in a regression is specified in the respective column heading; the maximum number of future periods' earnings in any model is four. The sample comprises company-period observations from 1983 through 1986.

[b] The adjusted R^2s are taken from regressions of returns on current period's earnings and successive combinations of future periods' earnings, where returns are measured over either (1) the current period or (2) the current and prior periods (ranging from one to four previous periods).

For example, when the return measurement period is the current and four prior quarters, current quarterly earnings alone yields an adjusted R^2 of 4.47 percent, compared to an adjusted R^2 of 13.38 percent when four future quarter earnings are included along with current earnings. Similar inferences are drawn from the semiannual and annual reporting periods. In summary, the results substantiate the inference that reported earnings possesses a significant recognition lag as reflected in the explanatory power of future earnings for current and past returns.

Some Specification Checks of the Returns-Earnings Relation

Some empirical evidence (with annual data) shows that lagged earnings are statistically associated with current returns, even in the presence of current earnings as another explanatory variable (Easton and Harris 1991). To be certain that our results are not affected by the exclusion of this variable, earlier tests are reexamined with explicit consideration of prior periods' earnings. The lack of theoretical guidance in the selection of which lagged earnings are important prompted us to include earnings back to eight prior periods in the analysis.

Results from the regression of current returns on current and lagged earnings, for quarterly reporting periods, are shown in panel A of table 8. The evidence indicates that certain prior periods' earnings are associated with current returns. Specifically, the inclusion of eight lagged earnings yields a 100 percent increase in adjusted R^2 relative to current earnings alone (0.77 percent compared with 0.39 percent from table 1). Nevertheless, in the context of this generalized model, current earnings continues to contribute to the explanation of returns; that is, the earnings coefficient ($\delta_{q1}=0.103$) is significant at the 0.001 level. This finding notwithstanding, the explanatory power of current and lagged earnings for returns is low, which is similar to the inference regarding table 1.[15]

The low incremental explanatory power of lagged earnings suggests that the evidence on recognition lag presented in earlier sections is unlikely to be affected by the inclusion of prior periods' earnings. The specification tests confirm our suspicion. Specifically, we regress current stock returns on current, lagged, and future earnings. The results, shown in panel B of table 8, indicate that inclusion of four future periods' earnings yields a 240 percent increase in adjusted R^2 relative to the regression in panel A (i.e., adjusted R^2 increases to 2.67 percent from 0.77 percent). Other diagnostic tests also confirm the robustness of prior tests. Specifically, a reexamination of the tests shown in table 4, which regress current returns on successive combinations of current and future earnings, is conducted with eight lagged earnings in all regressions. For quarterly periods, the adjusted R^2s from the sequential inclusion of four future periods' earnings equal 1.76, 2.22, 2.55, and 2.67 percent. Notice that these results are similar to those in the first row of table 4, which included no lagged earnings in the regression.[16]

VI. Summary and Conclusions

This article examines the effects of accounting recognition criteria on the relevance of earnings as an explanatory variable for returns. Unlike the market, which recognizes economic events when they occur, earnings recognition involves two sometimes conflicting qualities of relevance and reliability. Application of these accounting recognition criteria can impair the relevance of earnings in deference to reliability, and as a result, certain economic events are recognized in earnings with a lag. The primary focus of our investigation is threefold.

First, we hypothesize that accounting recognition criteria are determinants of earnings' explanatory power, and moreover, that the explanatory power is less for shorter reporting periods since these earnings measurements are predictably more sensitive to

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[15] We computed condition indexes (see Belsley et al. 1980) for each regression in this study. These indexes measure the degree of collinearity among the variables. Belsley et al. indicate that mild multicollinearity is present when the index is between 5 and 10, and is severe when the index exceeds 30. The maximum index in our regressions is 2.8, and most are below 1.5. We also computed the variance inflation measure suggested by Belsley et al. for each of our regressions. Belsley et al. indicate that severe collinearity exists when this measure exceeds 10; the highest measure for our regressions is 1.8.

[16] We also reexamined the evidence on recognition lag for industry classes based on companies' sensitivity to accounting recognition criteria (see table 5) when lagged earnings are included in all regression tests. All of these tests yield results similar to those reported here.

Table 8

Alternative Specifications of the Relation Between Current Quarterly Returns and Current, Lagged, and Future Quarterly Earnings

Panel A. Regression of Current Stock Returns on Current and Lagged Earnings:

(*Model:*[a] $R_{j,q}=\delta_{q0}+\delta_{q1}\bullet A_{j,q}/P_{j,q-1}+\delta_{q2}\bullet A_{j,q-1}/P_{j,q-1}+\delta_{q3}\bullet A_{j,q-2}/P_{j,q-1}+\delta_{q4}\bullet A_{j,q-3}/P_{j,q-1}+\delta_{q5}\bullet A_{j,q-4}/P_{j,q-1}$
$+\delta_{q6}\bullet A_{j,q-5}/P_{j,q-1}+\delta_{q7}\bullet A_{j,q-6}/P_{j,q-1}+\delta_{q8}\bullet A_{j,q-7}/P_{j,q-1}+\delta_{q9}\bullet A_{j,q-8}/P_{j,q-1}+\epsilon_{j,q}$)

Sample	$\hat{\delta}_{q0}$	$\hat{\delta}_{q1}$	$\hat{\delta}_{q2}$	$\hat{\delta}_{q3}$	$\hat{\delta}_{q4}$	$\hat{\delta}_{q5}$	$\hat{\delta}_{q6}$	$\hat{\delta}_{q7}$	$\hat{\delta}_{q8}$	$\hat{\delta}_{q9}$	Adjusted R² (%)	Sample Size
All Periods	0.04	0.10	−0.04	0.02	0.01	−0.05	0.02	−0.01	0.02	−0.02	0.77	24,150
	(38.9)	(11.8)	(−4.5)	(1.7)	(0.8)	(−6.8)	(1.9)	(−1.0)	(2.5)	(−2.0)		

Panel B. Regression of Current Stock Returns on Current, Lagged, and Future Earnings:

(*Model:*[a] $R_{j,q}=\lambda_{q0}+\lambda_{q1}\bullet A_{j,q}/P_{j,q-1}+\lambda_{q2}\bullet A_{j,q-1}/P_{j,q-1}+\lambda_{q3}\bullet A_{j,q-2}/P_{j,q-1}+\lambda_{q4}\bullet A_{j,q-3}/P_{j,q-1}+\lambda_{q5}\bullet A_{j,q-4}/P_{j,q-1}+\lambda_{q6}\bullet A_{j,q-5}/P_{j,q-1}$
$+\lambda_{q7}\bullet A_{j,q-6}/P_{j,q-1}+\lambda_{q8}\bullet A_{j,q-7}/P_{j,q-1}+\lambda_{q9}\bullet A_{j,q-8}/P_{j,q-1}+\lambda_{q10}\bullet A_{j,q+1}/P_{j,q-1}+\lambda_{q11}\bullet A_{j,q+2}/P_{j,q-1}$
$+\lambda_{q12}\bullet A_{j,q+3}/P_{j,q-1}+\lambda_{q13}\bullet A_{j,q+4}/P_{j,q-1}+\epsilon_{j,q}$)

Sample	$\hat{\lambda}_{q0}$	$\hat{\lambda}_{q1}$	$\hat{\lambda}_{q2}$	$\hat{\lambda}_{q3}$	$\hat{\lambda}_{q4}$	$\hat{\lambda}_{q5}$	$\hat{\lambda}_{q6}$	$\hat{\lambda}_{q7}$	$\hat{\lambda}_{q8}$	$\hat{\lambda}_{q9}$	$\hat{\lambda}_{q10}$	$\hat{\lambda}_{q11}$	$\hat{\lambda}_{q12}$	$\hat{\lambda}_{q13}$	Adjusted R² (%)	Sample Size
All Periods	0.04	0.06	−0.06	−0.02	−0.02	−0.05	0.01	−0.00	0.03	−0.02	0.14	0.11	0.11	0.06	2.67	24,150
	(36.0)	(6.6)	(−7.4)	(−2.1)	(−2.7)	(−6.2)	(1.1)	(−0.4)	(3.0)	(−2.4)	(11.7)	(8.3)	(8.4)	(5.6)		

[a] Stock returns ($R_{j,q}$) are measured from immediately after the prior period's earnings announcement through the current period's announcement; $A_{j,q}$ is reported earnings per share for time period q, and $P_{j,q-1}$ is the price per share of company j at time q−1. Parameter estimates and t-statistics (in parentheses) are presented for each regression. The sample comprises company-quarter observations from the first quarter of 1983 through the fourth quarter of 1986.

recognition criteria, and hence, exhibit substantial recognition lag. Results show that, while quarterly earnings is significant in explaining returns, its explanatory power is low. Furthermore, when the reporting period (for both earnings and returns) is increased, earnings' explanatory power substantially increases; for example, the adjusted R^2s equal 0.39, 1.78, 5.55, 15.19, and 39.76 percent for quarterly, semiannual, annual, biennial, and quadrennial periods, respectively. This evidence is consistent with the importance of accounting recognition criteria as determinants of earnings' explanatory power.

Second, evidence of a substantial lag in earnings recognition motivates tests of the extent and pattern of earnings recognition lag. Findings reveal a significant earnings lag for several periods and provide evidence that future periods' earnings are significantly related to current returns and are often of greater explanatory power for current returns compared with current earnings. For example, with biennial reporting periods, the adjusted R^2 from a regression of returns on earnings jumps to more than 29 percent with the inclusion of the next period's earnings. The evidence is characteristic of a substantial recognition lag in earnings that extends to several future periods.

Third, we hypothesize that earnings recognition lag is a function of cross-sectional differences in the application of accounting recognition criteria, as reflected in fundamental economic determinants of earnings measurement. Results show that earnings' explanatory power is substantially greater for companies whose earnings measurements are predictably less sensitive to accounting recognition criteria. For example, with biennial reporting periods, the explanatory power of a regression of current returns on current earnings exceeds 51 percent for companies least sensitive to recognition criteria, but is less than 18 percent for companies whose earnings measurements are most sensitive to these criteria. Moreover, the percentage increase in explanatory power of future earnings for current returns is lower for companies least sensitive to recognition criteria.

The robustness of our results is verified by additional tests where (1) we demonstrate that current earnings is significantly associated with several prior periods' returns, and (2) we show that when the dependent variable includes current and prior periods' returns in a regression of returns on both current and future earnings that none of this article's inferences are affected. For example, with annual periods, in a regression of returns (measured over the current and prior period) on current and future periods' earnings, future earnings continue to explain variation in returns and yield an adjusted R^2 of more than 32 percent. Finally, we demonstrate that a more general specification of the returns-earnings relation which explicitly includes lagged earnings (back to eight prior periods) does not affect any of this article's inferences. In summary, the evidence in this article underscores the existence of a substantial recognition lag in accounting earnings *and* the potential for significant improvement in earnings' explanatory power for returns.[17]

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[17] The issue of earnings' explanatory power has received increased attention with the Securities and Exchange Commission's (SEC) encouragement to use market-based measures in valuing certain securities. For example, in testimony before the Senate Committee on Banking, Housing, and Urban Affairs (U.S. Senate 1990a, 148–55), SEC Chairman Richard C. Breeden argued that:

> Determining the current value of an institution's assets, not recording their original cost, should increasingly be the goal toward which we must work. . . . The objective of these efforts should be to achieve financial reporting that uses appropriate market-based measures of valuation at the earliest

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> possible date. . . . The presumption that market-based information is the most relevant financial data attribute should be recognized.

Similar testimony was given by SEC General Counsel James R. Doty before the Judiciary Antitrust Subcommittee (U.S. Senate 1990b, 136), where he argued that "as the Commission's earlier testimony on this matter has made clear, the time has run out on 'once upon a time accounting.' "

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Market Perceptions of Reserve Disclosures Under SFAS No. 69

Greg Clinch
University of New South Wales
Joseph Magliolo
University of Pennsylvania

SYNOPSIS AND INTRODUCTION: Since the late 1970s, oil and gas firms have been required to include (unaudited) estimates of proved reserve quantities and valuations based on these estimates in their financial statements. As defined by the SEC, proved reserves are those that will be produced with "reasonable certainty" under existing economic conditions. In addition, firms must disclose estimated quantities of proved developed reserves, which will be produced from existing wells. At the time the proved reserve determination is made, substantial uncertainty exists as to the amount of oil ultimately recoverable, suggesting that the reserve estimation process is unreliable (Magliolo 1986b). Although certain constituencies have indicated interest in having firms disclose reserve quantities (see, e.g., Deakin and Deitrick 1982), the relevance of the disclosures for any given firm is an open question. It is to this issue that our research is directed.

Prior research has demonstrated a weak association between security prices and oil and gas valuation disclosures required by SFAS No. 69 (see, e.g., Harris and Ohlson 1987; Magliolo 1986a). At least two explanations could account for the weak association: (1) reserve quantity estimates underlying the valuation disclosures are unreliable, and (2) the valuation model used to attach value to reserve quantities is flawed. Although the valuation approach used in these "reserve recognition accounting" disclosures has been widely disparaged, much criticism also concerns problems in the estimation of oil and gas reserve quantities. This article narrows the focus

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of prior research and specifically examines the value-relevance of reserve *quantity* disclosures required by SFAS No. 69 (FASB 1982). This more narrow focus permits us to investigate, for the first time, one of the explanations for why the reserve valuation components do not appear to be particularly informative. It also allows us to compare the informativeness of management *claims* about reserve quantities in the SFAS No. 69 disclosures with quantity estimates that we infer from management *actions* (i.e., production of oil).

The article explores two empirical questions concerning reserve quantity disclosures. First, we examine the required SFAS No. 69 disclosures for proved reserves and proved developed reserves and ask whether these reserve estimates are value-relevant, given a benchmark estimate of reserves based on firms' current oil production levels. The second question is whether the association between market valuation and firms' reserve disclosures differs across firms according to characteristics of the disclosed data. Specifically, we determine whether investors' reliance upon SFAS No. 69 reserve quantity disclosures is related to variation in the reliability of such disclosures across firms, as indicated by the absolute size and direction of reserve estimate revisions, as well as the ratio of proved developed to total proved reserves. Each of these factors potentially provides information on the reliability or usefulness of reserve disclosures.

In our first tests, which do not allow for firm-specific variation in the informativeness of SFAS No. 69 quantity disclosures, we find no evidence that disclosures based on proved reserves and proved developed reserves provide additional value-relevant information to market participants once production is known. However, when we partition our sample, we find that the proved reserve information is informative for a subset of firms whose reserve quantity estimates appear more reliable.

The importance of our results extends beyond the oil and gas accounting area. The differential reliability results represent some of the first capital-markets-based evidence that the informativeness of a disclosure varies in accordance with the accuracy of management projections. Stated differently, our evidence suggests that investor reliance on disclosures varies as a function of their "quality." Also, our initial results that disclosures of proved reserve quantities provide no information once production is known suggest a reliance by investors on the "objective" information provided by management actions (production decisions) rather than the (potentially) subjective estimate of proved reserves.

Key Words: *Value-relevance, SFAS No. 69, Proved reserves, Generalized least squares.*

Data Availability: *A list of sample firms, SFAS No. 69 data, and oil price data employed in the study are available from the authors. Stock price data are available on the relevant CRSP databases.*

THE remainder of the paper is divided into four sections. In section I we develop a model that links oil prices to the value of an oil and gas firm, and outline the market model procedures used in designing our empirical work. The sample of firms is described in section II, with our results presented in section III. Our conclusions are provided in section IV.

I. Theoretical Development

In general, the market's valuation of a firm's oil reserves will be a function of (among other factors): (1) reserve production volume, (2) expected production timing, (3) expected sale prices in future periods, and (4) expected discount rates. Estimates of all of these items are required to determine the present values of future cash flows from oil and gas operations. However, none of these items is observable to the researcher, and there is little theoretical guidance on the mapping from observable data to these items, or from these items to firm value. To make the problem manageable, we structure the market's valuation of oil and gas reserves using a general specification based on Hotelling's (1931) work (see Miller and Upton 1985a and Magliolo 1986b):

$$V_{Oil,it}=\eta_t(p_t-c_{it})S_{it}, \tag{1}$$

where $V_{Oil,it}$ denotes the value placed on firm i's oil-producing activities, p_t and c_{it} denote the unit oil price and extraction cost, respectively, S_{it} is the market's assessment of the firm's total reserve quantity at t, and η_t is a firm-specific parameter. The parameter η_t captures both industrywide and firm-specific factors (related to estimating the present value of cash flows from oil operations).

Consider first industrywide factors. Among other things, η_t will reflect the rate of increase in the price of oil relative to interest rates. If oil prices were assumed to increase at the rate of interest, and if unit extraction costs were invariant with production (i.e., total production costs in a period equal quantity extracted times a constant), the predicted value for η_t is 1 in the absence of corporate taxes. This prediction is attributable to Hotelling (1931), and although we do not rule it out, we do *not* assume that Hotelling's model provides an exact characterization of the value of the firm's reserves. Despite the intuitive appeal of the Hotelling prediction, the empirical evidence suggests that it does not hold. For example, evidence in Miller and Upton (1985b) and Magliolo (1986a) suggests that market participants expect real oil prices to increase much more slowly than the real rate of interest, which is consistent with the observed real price pattern of a number of natural resources.[1] To the extent that (1) oil prices are expected to evolve more slowly than the rate of interest and (2) sample firms cannot pump oil arbitrarily quickly (or it is prohibitively costly to do so), the η_t coefficients could be much smaller than 1 (or even the tax-deflated prediction of 1 minus the tax rate made in Magliolo 1986a).

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[1] Schmidt (1988) presents evidence for the observed real-price path of copper, zinc, iron, lead, and oil over the last 120 years. In principle, all of these commodities can be viewed as exhaustible resources, and yet their price paths do not track the rate of interest. Schmidt also describes a number of theoretical papers that explore why natural resource prices do not rise with the rate of interest.

Next consider possible firm-specific sources of variation in the η_i coefficients. As noted in Magliolo (1986a), η_i will vary cross-sectionally as a function of the different tax rates faced by firms (e.g., taxes on production of North Sea oil[2]). An additional source of variation in η_i will be risk differences across firms; as risk varies, so will the discount rate applied to expected future oil-related cash flows underlying equation (1). We do not attempt to build such factors directly into equation (1), but we do incorporate proxies in our empirical procedures and find some evidence that the η_i coefficients vary as a function of these proxies.

Restating equation (1) in terms of weekly oil price changes, and assuming that c_{it} and S_{it} do not change over a single week yields:[3]

$$\Delta V_{Oil,it}=\eta_i S_{it}\Delta P_{Oil,t}, \tag{2}$$

where $\Delta V_{Oil,it}$ and $\Delta P_{Oil,t}$ represent the weekly change in the market value of oil operations and oil price, respectively. Our next step is to imbed equation (2) in a general model of firm stock returns. This is necessary since the left-hand side of equation (2) is not observable. We employ the standard market model as the unconditional return-generating process, but tailor it to oil companies by assuming that the residual can be divided into a component arising from oil price changes and a component arising from all other sources. We also adopt the assumption that market model residuals represent unexpected changes in firm equity values divided by the (beginning-of-week) market value of the firm's equity securities. Under these assumptions, with equation (2), the empirical model actually estimated is:

$$R_{it}=\alpha_i+\beta_i R_{mt}+\gamma_i(\Delta P_{Oil,t}/V_{it-1})+\epsilon_{it}, \tag{3}$$

where:

R_{it} is the dividend-adjusted rate of return for firm i in week t,
R_{mt} is the return on the market portfolio in week t,
V_{it-1} is the beginning market capitalization of equity for firm i in week t,
ϵ_{it} is an error term specific to firm i in week t, and
α_i, β_i, and γ_i are firm-specific parameters.

This provides us with an estimate of the oil price response coefficient (γ_i).[4] In a second stage, we regress estimated γ_i coefficients on firm-specific reserve disclosures (e.g., the barrels of proved reserves disclosed by the firm). It is clear from equations (2) and (3) that the regression coefficient γ_i will have imbedded within it an estimate of the firm's reserve quantity (in terms of equation (2), an estimate of $\eta_i S_{it}$). Consequently, the cross-sectional regressions provide evidence on the degree of association between market perceptions and firm disclosures. In particular, the cross-sectional regression coefficients will reflect the relative weights placed on SFAS No. 69 disclosures by investors in forming a market estimate of reserve quantities. We use this evidence to infer market perceptions of the reserve disclosures made by companies in our sample.

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[2] As an example of high tax rates on foreign production, disclosures made by Ranger Oil suggest that taxes on its North Sea reserves exceed 80 percent of revenues less production costs.

[3] If c_{it} and S_{it} do change across weeks, equation (3) still holds with the addition of an error term to capture changes in these variables.

[4] We effectively assume that none of the change in the value of oil and gas operations is captured by $\beta_i R_{mt}$. As an empirical matter, the correlation between oil price changes and the market return during our sample period is 0.05. Thus, it is unlikely that the inclusion of a market return variable will have any effect on the size of our estimated γ coefficients.

Our basic empirical analysis regresses the observed γ_i coefficients on proved reserves, proved developed reserves, and production figures, which can be viewed as alternative signals from which the market extracts information about a firm's estimate of its reserves. Proved reserves and proved developed reserves are analyzed because they are the two total quantity estimates reported under SFAS No. 69, and they underlie the standard's key disclosures. We include current production as a competing source of information because of the apparent importance placed on production numbers in industry reserve estimation practices. For example, a reserve estimation technique known as "decline curve" analysis estimates total reserves by "grossing up" current production on the basis of an extrapolated production rate. Under the (unrealistic) assumption that current production can be converted to a total reserve number in the same way for all firms, production can be viewed as a fundamental information source about total reserves.[5] Moreover, since the production decision is based on all of management's information, unlike total proved reserves, production is not an artifact of exogenously imposed reporting rules. Thus, production could be useful in forecasting the future performance of a firm. In addition, there is no latitude in how production is calculated, so it could represent a much "harder" number than proved reserves. The role of our cross-sectional regressions is to determine which of the reserve quantity and production measures is associated with the market's estimate of reserves imbedded in the oil price response coefficient.

The approach outlined differs in some respects from the conventional one used in cross-sectional capital markets research. In particular, in most two-stage regression applications (such as the ones discussed in Bernard 1987), residuals from basic market model regressions are used as the left-hand-side variable in the second-stage regressions. The independent variables of interest are then deflated by equity market value in the second stage to mimic the "implicit" deflation from the first stage. The analogous approach in our context would require first-stage regressions of the following form:

$$R_{it}=\alpha_i+\beta_i R_{mt}+\gamma_i(\Delta P_{Oil,t})+\epsilon_{it}. \tag{4}$$

The second stage of the analysis under this scheme would require cross-sectional regression of estimated γ_i coefficients in equation (4) on (market value) deflated reserve and production values. A disadvantage of this approach arises from constraining the deflation factor to be constant across the estimation period, whereas the specification in equation (3) allows the deflation to vary weekly in accord with the left-hand-side variable. A potential advantage of equation (4) is that the variables in the second-stage regressions will have a much narrower scale than those based on the first-stage regressions shown in equation (3). Although we employ equation (3) in our reported results, we repeat our analysis using equation (4). As indicated in sections III and IV, there are few qualitative differences in our results across the two approaches.

II. Sample Selection and Description of Data

A sample of 86 firms was selected on the basis of the following criteria:

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[5] Such an assumption is unrealistic for a variety of reasons. Because firms produce from wells that are at varying stages of maturity, production from older (newer) wells translates into a smaller (larger) total reserve volume. Also, a reserve estimate based only on current production ignores any undeveloped reserves (i.e., reserves not currently being produced).

1. The firm was classified by SIC code 131 (crude oil and natural gas exploration and production), 138 (oil and gas drilling and services), or 291 (petroleum refining) on the 1987 CRSP daily New York Stock Exchange/American Stock Exchange (NYSE/AMEX) or over-the-counter (OTC) tapes.
2. The firm had continuous daily return data for 1984–87.
3. SFAS No. 69 data for 1984–87 were available from either company annual reports, or annual issues of *Oil and Gas Reserve Disclosures*, published by Arthur Andersen, Inc.

Of the 86 firms, 52 are in SIC industry 131 (of which 18 are OTC), 18 are in industry 138 (no OTC firms), and 16 are in industry 291 (no OTC firms). The sample period consists of 208 weekly returns from January 1984 through December 1987. We analyze weekly rather than daily returns to avoid the generally poor fit of daily returns models.

A sample of weekly changes in oil futures prices was obtained from back issues of *The Wall Street Journal*. We collected price data for a benchmark crude oil known as "West Texas Intermediate" for futures contracts calling for delivery in two months.[6] We arbitrarily chose weekly changes from Wednesday to Tuesday of the following week, and recorded the "settle" price listed in the *Journal*. For example, for March 1986, we would record the change in settle price on the May 1986 contract. In the week overlapping March and April, we would continue to record the change in price of the May contract. In the first full week of April, we would record the change in price for the June contract.

As discussed previously, our primary empirical procedure involves estimating firm-specific oil price response coefficients in equation (3), and cross-sectionally regressing these against firms' SFAS No. 69 reserve disclosures. Panel A of table 1 provides some descriptive statistics concerning the individual firm market model regressions, average production, proved reserves, and proved developed reserves for our sample firms over the 1984–87 period. Also presented are descriptive statistics for oil prices and oil price changes during the sample period. Not surprisingly, there is large cross-sectional variation in the estimated γ coefficients, which reflect the disparate reserve stocks of the sample firms. Formal statistical tests rejected null hypotheses of equal oil price coefficients in cross-section (for each year) and equal coefficients across the four sample years (for each firm).[7] For comparative purposes, we also have divided the estimated γ coefficients by the yearly proved reserves over the sample period and presented the resulting ratios in the table.

In panel B of table 1, we present descriptive statistics of γ coefficients from market model regressions based on equation (4), without market value deflation of oil prices in time series. Thus, unlike those in panel A, the coefficients in panel B do not reflect differences in size (as measured by market value). Although we do not present results disaggregated by SIC code, there is little difference in the distributions of γ_i coefficients across the different industry groups in the regressions based on equation (4).[8] This

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[6] We chose to use futures prices to avoid the apparent "noise" in quoted spot prices. However, we also collected spot price data and prices for futures that called for delivery in three, four, five, and six months. Our results are not sensitive to the choice of oil price employed.

[7] Tests were performed by using standard asymptotic procedures based on suitable parameter restrictions in equation (3) across the 86 sample firms. The tests incorporate estimated cross-sectional covariation in market model residuals, but assume homoskedasticity in time series for each firm.

[8] We also divided firms in the 131 classification (the only group with OTC firms) into those listed on the NYSE or AMEX and those listed OTC. The median γ_i coefficient for the OTC group is 0.024; the median for the NYSE/AMEX firms in the 131, 138, and 291 classifications is 0.019.

Table 1
Sample Descriptive Statistics (1984–87)

Panel A. Equation (3) Regressions, SFAS No. 69 Data, and Descriptive Statistics of Independent Variables:

	1st Quartile	*Median*	*3rd Quartile*	*Average*	*Standard Deviation*
Market Model Regressions[a]					
α	−0.005	−0.002	0.000	−0.002	0.004
β	0.572	0.784	0.973	0.782	0.295
γ−1984	−645.5	242.2	5830.1	21737.0	76469.0
γ−1985	157.8	1403.7	6701.2	17291.0	49965.0
γ−1986	76.4	894.1	6998.3	20099.0	68796.0
γ−1987	319.1	1519.0	8511.7	33906.0	102371.0
SFAS No. 69 Reserve Disclosures					
Average Production (1984–87)	227.5	762.6	3783.5	27728.9	89087.8
Average Proved Reserves (1984–87)	1974.5	7642.0	25650.8	273359.9	923089.3
Average Proved Developed Reserves (1984–87)	1460.0	6897.5	24033.3	215928.6	696511.8
Estimated γ Scaled by Proved Reserves					
γ/Proved Reserves−1984	−0.057	0.087	0.287	0.202	0.756
γ/Proved Reserves−1985	0.039	0.105	0.326	0.297	0.671
γ/Proved Reserves−1986	0.041	0.083	0.219	0.171	0.345
γ/Proved Reserves−1987	0.085	0.182	0.465	0.418	1.181
Oil Price Data (2-Month Future)					
Oil Futures Price	17.50	25.20	28.60	22.74	6.220
Weekly Change in Futures Price	−0.405	0.025	0.398	−0.060	0.834

(Continued)

Table 1—*Continued*
Sample Descriptive Statistics (1984–87)

Panel B. Equation (4) Regressions with Undeflated Oil Price Changes:

	1st Quartile	*Median*	*3rd Quartile*	*Average*	*Standard Deviation*
Market Model Regressions[b]					
γ	0.004	0.013	0.024	0.014	0.018
$t(\gamma)$	0.342	1.303	2.249	1.361	1.420
Production/Market Capitalization	0.005	0.009	0.016	0.013	0.017
Proved Reserves/Market Capitalization	0.037	0.072	0.151	0.133	0.229
Proved Developed Reserves/Market Capitalization	0.026	0.054	0.115	0.088	0.102

[a] The regression is: $R_{it}=\alpha_i+\beta_i R_{mt}+\gamma_i \Delta P_{Oil,t}/V_{it-1}+\epsilon_{it}$, where R_{it} is the weekly stock return for firm *i*, R_{mt} is the weekly (equally weighted NYSE/AMEX) market return, $\Delta P_{Oil,t}$ is the weekly change in the oil futures price, V_{it} is the market capitalization for firm *i* at time *t*, and ϵ_{it} is an error term. In estimating the market model we allow the oil price response coefficient (γ) to vary across the four sample years. The γ coefficients and proved reserve quantities are denominated in thousands. In the scaled results reported in the table, the estimated γ coefficient from each year is scaled by that firm/year's proved reserves. Market model results are reported for 86 firms. The oil price data refer to weekly oil futures prices and (208 weekly) price changes for the future calling for delivery in two months.

[b] The regression is: $R_{it}=\alpha_i+\beta_i R_{mt}+\gamma_i \Delta P_{Oil,t}+\epsilon_{it}$, where R_{it} is the weekly stock return for firm *i*, R_{mt} is the weekly (equally weighted NYSE/AMEX) market return, $\Delta P_{Oil,t}$ is the weekly change in the oil futures price, and ϵ_{it} is an error term. In estimating the market model, we allow the oil price response coefficient (γ) to vary across the four sample years. The *t*-statistics are those appropriate for evaluating the null hypothesis that the annual γ coefficient is equal to 0. The figures reporting reserve quantities deflated by market capitalization are calculated separately for each year. As an example, for 1985, production/market capitalization was calculated for a given firm by dividing reported production in 1985 by the (equity) market capitalization at the end of 1984. Reported results are aggregated across the four sample years.

observed similarity is important, since we aggregate the γ_i coefficients into a single sample in our cross-sectional results. Prior research of SFAS No. 69 disclosures has either omitted larger, integrated firms (Harris and Ohlson 1987; Magliolo 1986a) or separated these firms from those involved only with exploration and production (Doran et al. 1988).[9]

The results in table 1 indicate that the observed coefficients are smaller than the predictions made in prior research based on the Hotelling model (Magliolo 1986a; Miller and Upton 1985a, 1985b). For example, the median ratio of γ to estimated proved reserves (reported in panel A) ranges from 0.09 to 0.18, as opposed to the Hotelling-based prediction of 1 minus the tax rate (Magliolo 1986a). This pattern also is reflected when the estimated γ coefficients in panel B are compared to the various ratios of reserve quantity to market capitalization in the table. Under a Hotelling prediction, these estimated coefficients would be roughly half the size of the proved-reserve-to-market-capitalization ratios (assuming a tax rate of 50 percent). Some of this "shortfall" might be attributed to the high taxes paid by firms producing in foreign countries, but this would not explain the size of the coefficients across the full sample.

In considering the size of the coefficients, two items are noteworthy. First, the small size relative to the Hotelling prediction could be a manifestation of misspecification in the empirical model and/or measurement error. For example, we assume that changes in the price of West Texas Intermediate oil captures price changes for all our firms. As a practical matter, firms have many different grades and types of oil. The single futures price that we use may be a noisy proxy for the actual price change experienced by each firm. Moreover, to enable estimation, we constrain the oil price response coefficients to be constant across each year. No such constraint is implied by the model development in section 1.

Second, as suggested previously, the Hotelling model may be misspecified. If it is assumed that firms cannot accelerate production arbitrarily quickly, the observed coefficients suggest that oil prices are expected to increase more slowly than the rate of interest. If expectations were for prices to be literally flat and production to be constant, production occuring in future years would be heavily discounted. This discounting would manifest itself in our empirical work through low γ coefficients. The exact effect of deviation from the Hotelling prediction on the magnitude of the coefficients is unclear, because we cannot separate the effects of these expectations from effects of misspecification and measurement error. However, a number of related studies that employ different research designs have documented the same coefficient "shortfall" (see, e.g., Miller and Upton 1985b). We performed a number of diagnostics on subsets of our sample firms, including variants of the approaches of Magliolo (1986a) and Miller and Upton (1985a, 1985b) with similar results. It appears that a substantial portion of this "shortfall" is attributable to the same combination of factors affecting prior studies, rather than problems we introduce through our research design.

III. Empirical Results

We first explore the relative informativeness of the three reserve quantity disclosures: production, proved reserves, and proved developed reserves. We address this issue by performing cross-sectional multiple regressions of yearly estimated oil price response coefficients (the γ_i coefficients from the equation (3) time series regressions) on production, proved reserves, and proved developed reserves for each year in the 1984–87 period.[10] Standard assumptions made in regression contexts are unlikely to hold in our analysis. In particular, given the size disparity in reserve volumes, and given that we focus on firms in a particular industry over a particular time period, assumptions of residual independence and homoskedasticity are unlikely to hold. In view of this, we employ a generalized least squares (GLS) procedure, using results from the firm-specific market model estimations to construct the GLS weighting matrix. Details of the procedure are described in the appendix.

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[9] We repeated the empirical analyses described subsequently for subsamples of firms formed by eliminating each industry in turn (and eliminating OTC firms). The results exhibited little sensitivity to this procedure, although a general lessening of significance levels reflected the reduced number of firms.

Table 2 presents the initial cross-sectional regressions for each year in the 1984–87 time period. Results from a χ^2-test of the (joint) null hypothesis that the coefficients from all four years are equal to 0 are also presented.[11] The evidence in table 2 generally suggests that production is informative, but there is little evidence that proved reserves or proved developed reserves are informative (given production). The only year in which reserves are significant is 1987. In that year, the null hypothesis that the coefficient on proved developed reserves is equal to 0 could be rejected at the 10 percent level (two-tailed test).

We performed numerous sensitivity checks to ensure that our results were not unduly influenced by various aspects of the research method. One concern is that all our procedures ignore gas reserves and changes in gas prices. If oil price changes are correlated with omitted gas price changes, and the oil production and reserve variables are differentially correlated with omitted gas reserves, our reported results could reflect this omission. Given the unavailability of appropriate gas price data, we investigated such a possibility by repeating the regressions in table 2 and including gas reserve variables (production, proved reserves, and proved developed reserves) in addition to the oil reserve variables. The inferences drawn are unchanged. Thus, our results do not appear to be attributable to the omisssion of gas reserve information.

We also conducted tests that attempted to account for firm-specific variation in taxes and risk levels. As noted in section I, our research design does not explicitly incorporate differences in taxes and risk levels across firms, Instead, we allow these factors to be imbedded in the estimated oil price response coefficient. If these factors are correlated with our oil reserve variables, a correlated omitted-variables problem may arise. To check this possibility, we included proxies for taxes and risk and repeated the regressions reported in table 2.[12] Inclusion of these proxies in our regres-

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[10] Note that since proved reserves equal the sum of proved developed and undeveloped reserves, an examination of the value-relevance of proved developed reserves should ideally examine the sum of the proved and proved developed reserve coefficients. We chose our presentation to remain consistent with the actual disclosures required by SFAS No. 69. However, our conclusions are unchanged when the sum of the estimated reserve coefficients is examined.

[11] There is one degree of freedom for each restriction (year). We also calculated χ^2-statistics to determine whether the average coefficient across four years was equal to zero, and jointly tested both proved reserves and proved developed reserves coefficients across all four years against zero. The results of these tests were consistent with our reported results.

[12] The tax rate proxy is based on the change in the estimated extraction cost disclosed under SFAS No. 69 divided by proved reserves (where extraction costs include excise tax estimates) between 1985 and 1986, representing the largest year-to-year oil price change (and therefore the largest year-to-year excise tax change) in our sample period. Thus, our proxy measures the change in the per unit extraction cost. Our proxy for risk was simply the estimated market model beta for each firm.

Table 2
Cross-Sectional Regressions Involving SFAS No. 69 Reserve Disclosures

	Annual Regressions of Oil Price Response Coefficients on Reserve Data									
	1984		*1985*		*1986*		*1987*			
Variable	*Coefficient*	*t*	*Coefficient*	*t*	*Coefficient*	*t*	*Coefficient*	*t*	*Average Coefficient*	χ^2
Intercept	−157.24	−1.95	−12.54	−0.53	−16.32	−1.87	−19.01	−0.99	−51.28	8.560
Production	0.17	0.49	0.51	2.51	0.31	4.26	0.44	1.97	0.36	28.313
Proved Reserves	−0.01	−0.20	−0.00	−0.16	0.00	0.57	0.00	0.22	−0.00	0.429
Proved Developed Reserves	0.05	1.32	−0.03	−1.08	−0.01	−1.03	0.05	1.73	0.02	6.908

Note: The *t*-statistics are those appropriate for testing the null hypothesis that the corresponding regression coefficient is equal to 0. The χ^2-statistic tests the null hypothesis that all four yearly coefficients are equal to 0. Given four degrees of freedom, the 10, 5, and 1 percent cutoff levels are 7.779, 9.488, and 13.277, respectively.

sions resulted in a (marginally) significant coefficient for the tax proxy and no significance for the risk proxy. More importantly, the coefficients on oil reserve and production variables remained largely unchanged, leading to the same inferences drawn from results reported in table 2.

A further check involved repeating the cross-sectional regressions by using estimated oil price response coefficients from equation (4) (with undeflated oil price changes). As noted previously, these regressions are closer to the conventional form used in the two-stage applications discussed in Bernard (1987). Using this approach, we find no qualitative difference from the results in table 2. This trend persists over a wide range of estimation techniques.[13]

We also checked our results in table 2 via an alternative procedure that involved cross-sectionally regressing the absolute values of weekly market model residuals (estimated without oil price changes in the model) against the three oil reserve variables. The advantage of this approach is that it allows the cross-sectional relation to change over short intervals (a week), in contrast to the assumption of stationarity over one year implicit in the table 2 results. Results from this alternative procedure were entirely in accord with those reported in table 2.

Finally, although our results strongly indicate that production dominates SFAS No. 69 reserve disclosures as a source of value-relevant information to the market, this may indicate only that there is a very weak link between *current* oil price changes and change in value of oil and gas reserves. For example, if current oil price changes were not expected to persist beyond the end of the current year, the only valuation implication would be associated with current production, not future reserve levels (and might be likened to a "transitory earnings" effect). Under these circumstances, our results would reflect transitory oil price changes, rather than the dominance of production over reserve disclosures in terms of value-relevance.

Examination of autocorrelations from the oil price change series revealed no indication of transitory price changes over our sample period. As an additional check, we performed three annual cross-sectional regressions (for the 1984–86 period) of oil price response coefficients on current production and 1987 production. Thus, for 1984 we regressed 1984 estimated oil price response coefficients on 1984 production and 1987 production, while for 1986 we regressed 1986 coefficients on 1986 and 1987 production. If the table 2 results reflect transitory oil price changes, current production should dominate 1987 production in each of the three regressions. As table 3 indicates, this is not the case. Instead, 1987 production appears to dominate current production. The results suggest that oil response coefficients reflect market-based estimates of *future* production levels even though they are not related to management disclosures of proved reserves.

Note finally that the results in table 3 provide a crude means of assessing the validity of our valuation model. We suggested previously that our low estimated γ coefficients could reflect expectations that oil prices will not rise quickly. Assuming that it is not economically viable for firms to produce their entire reserve stock now, such

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[13] For example, Bernard (1987) argues for the estimation of coefficients with ordinary least squares and tests based on the full variance-covariance matrix of residuals. This is essentially the approach used in Doran et al. (1988). Using this approach, we find results that lead to the same conclusions as those reported in table 2. We also employed weighted least squares estimation as an alternative to the GLS technique; the results are entirely consistent with (and stronger than) those reported in table 2.

Table 3

Cross-Sectional Regressions of Oil Price Response Coefficients on Current and Future Production

Variable	*1984*		*1985*		*1986*		*Average Coefficient*	χ^2
	Coefficient	*t*	*Coefficient*	*t*	*Coefficient*	*t*		
Intercept	−95.35	−1.81	−15.54	−0.70	−19.81	−2.43	−43.57	9.671
Current Production	0.23	0.98	−0.05	−0.24	−0.14	−0.95	0.01	1.921
1987 Production	0.34	1.54	0.41	1.94	0.45	2.75	0.39	13.698

Note: The *t*-statistics are those appropriate for testing the null hypothesis that the corresponding regression coefficient is equal to 0. The χ^2-statistic tests the null hypothesis that all three yearly coefficients are equal to 0. Given three degrees of freedom, the 10, 5, and 1 percent cutoff levels are 6.251, 7.815, and 11.341, respectively.

expectations would cause the present value of cash flows in the near term (e.g., those associated with current production) to be more heavily weighted than those in the more distant future. Our methodology could therefore bias us against finding that proved reserves are value-relevant because current production receives the most weight in the market's valuation model. The results presented in table 3 are inconsistent with this conclusion and suggest instead that market participants are attempting to look ahead to value the firm, and that they place significant "present value weight" on events expected to occur in the future.

Cross-Sectional Differences in Value-Relevance of Reserve Disclosures

Although there is no evidence that the total proved volumes are informative in the results for our full sample, it remains possible that the disclosures do provide relevant information to investors for some firms. In particular, investors may perceive the disclosures as more or less reliable because of various observable characteristics of the data. We explore such differential informativeness by building on the regression summarized in table 2 with the addition of several "interaction" terms. The interaction variables are formed as the product of the proved reserve measure underlying table 2 and three dummy variables.[14] To obtain the dummy variables, we computed the variables described below using all available data in the years 1979–87. If the variable value was above (below) the median value for the sample it was assigned a value of 1 (zero). Consequently, coefficients on the interaction variables indicate (potential) differential value-relevance of proved reserves according to the interaction being considered.[15]

Average Absolute Revisions. To calculate this variable, we divided the absolute value of reported oil revisions in each year for which data were available by the beginning of year proved oil reserve estimate. Because this estimate is an absolute measure, we interpret it as a proxy for the uncertainty of a firm's reserve estimates. We expect risk-averse investors to place less reliance on reserves that they perceive to contain more error. Thus, we expect a negative relation between this interaction variable and oil price response coefficients.

Average Revisions. This variable is calculated in the same way as the absolute revisions variable, except that the actual (signed) revision figure is used, thus accounting for the *direction* of revisions. If some firms systematically under- or overestimate disclosed reserves, investors would be expected to adjust upward or downward. We therefore expect there to be a positive relation between this interaction variable and the oil price response coefficient.

Proved Developed to Proved Reserves. The variable is calculated by using all available data from the years 1983–87. Since proved developed reserves will be produced from existing wells, we hypothesize that less uncertainty is associated with these reserves. Risk-averse investors should therefore attach a higher value to proved developed reserves than to reserves that are proved but not developed. We therefore expect a positive relation between this interaction variable and oil price response coefficients.

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[14] We employed proved reserves alone (and not proved developed reserves) since the disclosures used to generate dummy variables all pertain to *total* proved reserves, not its components. For example, revisions of previous reserve disclosures are not broken down in terms of proved developed reserves. Thus, it is not clear what implications the interaction variables have for the proved developed reserve number.

[15] We employ indicator (dummy) variables because of the likelihood that these variables are measured with error, and to mitigate the effect of outlier observations. We also performed the empirical work reported in table 4 using the continuous counterparts of the dummy variables. We conducted our tests with and without the elimination of outlier observations. In general, we observed results similar to those reported in table 4. However, consistent with existence of measurement error, the significance levels for the interaction variables were somewhat less pronounced than those reported in the table.

Although these proxies are *ad hoc*, they capture the flavor of two recurrent criticisms of proved reserve disclosures: uncertainty and bias.[16] Industry experts routinely attach substantial uncertainty to proved reserve estimates, and anecdotal evidence from our sample confirms spectacular uncertainty in the estimation.[17] To the extent that market participants can anticipate such uncertainty, we would expect them to attempt to discount the disclosures accordingly. Our proxies for absolute revisions and proved developed reserves are intended to capture this discounting. Also, our discussions with participants in the oil industry suggest that some firms (including some very large ones) are extremely aggressive in their reserve estimates. Our average revisions proxy is an objective attempt to capture this industry folklore, with the assumption that any systematic aggressiveness (or conservatism) is "corrected" in subsequent revisions.

Results from the regression including the interaction variables are reported in table 4, with separate results reported for each year. The coefficients have the predicted signs, and each is significant at conventional levels in at least two of the four years. Moreover, for each coefficient, the χ^2-test indicates that all yearly estimates are not equal to zero. Such results suggest that market participants place differential reliance on the total reserve information disclosed by firms. Notably, the significance of the variable for average absolute revisions suggests a differential reliance, depending on the uncertainty attached to the reserves. Stated differently, a lower certainty equivalent is attached to reserves that have exhibited greater past revisions. Such a relation is exactly what one would predict of risk-averse investors. Our results based on the average revisions interaction term also suggest that market participants are making "quality" adjustments to the disclosed figures, adjusting the estimates of systematically optimistic firms downward and adjusting estimates of systematically pessimistic firms upward. As noted in the introduction, these results on differential reliability represent some of the first capital-markets-based evidence that the informativeness of a disclosure depends on its quality. The extant research we are aware of focuses on the relation between disclosure quality and earnings response coefficients (see e.g., Collins and DeAngelo 1990 and Imhoff 1989), and our results can be interpreted analogously.

The interaction variable based on the ratio of proved developed to total proved reserves is also a significant explanatory variable. Thus, the distinction between proved reserves and proved developed reserves appears to be value-relevant, contrary to the results reported in table 2. Table 4 indicates that proved reserves are more informative if they reflect primarily proved developed reserves. Alternatively, our results suggest that, on average, market participants value proved developed reserves more highly than undeveloped ones.[18]

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[16] Several studies have explored uncertainty and bias in SFAS No. 69 (and related oil and gas) disclosures, although not in a capital markets context. See Alciatore (1990) for a review of these studies.

[17] Connor (1979) reports claims by oil industry participants that "discovery date" estimates frequently will change by plus or minus 85 percent of the amount originally estimated. In 1980, one of our sample firms, Basic Earth Science Systems reported discoveries of 2.8 million barrels of oil and 20.3 billion cubic feet of gas, which increased the firm's reserve stock to 4.4 million barrels of oil and 23.9 billion cubic feet of gas. In 1981, Basic subsequently lowered its estimate of its oil reserves by 2.5 million barrels and gas reserves by 14.9 billion cubic feet.

[18] We performed many sensitivity checks similar to those discussed with reference to the table 2 results, with no substantial changes to the inferences we draw.

Table 4

Cross-Sectional Regressions Involving SFAS No. 69 Reserve Disclosures and Interaction Terms

	Annual Cross-Sectional Regressions of Oil Price Response Coefficients on Reserve Data Including Interaction Terms									
	1984		1985		1986		1987			
Variable	*Coefficient*	*t*	*Coefficient*	*t*	*Coefficient*	*t*	*Coefficient*	*t*	*Average Coefficient*	χ^2
Intercept	−6.81	−0.11	27.73	0.92	−3.02	−0.27	6.73	0.30	6.16	1.021
Production	−0.12	−0.39	0.48	3.29	0.25	4.41	0.19	1.26	0.20	31.864
Proved Reserves	0.02	0.64	−0.01	−1.28	−0.00	−0.11	0.01	0.57	0.00	2.385
Interactions With Proved Reserves										
Average Absolute Revisions	−0.09	−2.40	−0.04	−1.93	−0.02	−1.95	0.01	0.39	−0.03	13.440
Average Revisions	0.04	2.54	−0.01	−1.03	0.00	0.18	0.03	2.26	0.01	12.653
Proved Developed to Proved Reserves	0.05	3.41	0.01	1.28	0.01	1.18	0.04	2.19	0.03	19.455

Note: The t-statistics are those appropriate for testing the null hypothesis that the corresponding regression coefficient is equal to 0. The χ^2-statistic tests the null hypothesis that all four yearly coefficients are equal to 0. Given four degrees of freedom, the 10, 5, and 1 percent cutoff levels are 7.779, 9.488, and 13.277, respectively.

IV. Conclusion

Our results suggest that proved reserve disclosures are not incrementally informative for many firms, given production information. Such a conclusion questions the usefulness of required SFAS No. 69 disclosures, particularly given the central importance of proved reserve quantities in generating much of the mandated supplementary information. Given only proved reserve quantity and production information, market participants would appear to rely on the more objective production measure, which reflects an optimizing decision by management based on all of its information. This dominance occurs even though proved reserves could provide a more encompassing measure of a firm's reserve stock. These results provide a potential explanation for the apparent weak association found by previous researchers between SFAS No. 69 valuation information and security prices. However, we provide evidence consistent with proved reserves as a relevant information source for a subset of firms, whose disclosures are more reliable.

The differential informativeness indicated by our results raises some interesting financial reporting questions. The results in table 4 suggest that market participants anticipate management influence over reserve disclosures, and adjust accordingly. We have interpreted this influence as evidence of the differential quality of disclosures across firms. From a financial-reporting standpoint, the desirability of such influence is an open question, and it is unclear that the reported data possess the requisite degree of comparability desired by accounting regulators. Also unclear is why influence over these numbers would be in the management's interest.

Our results also suggest that market participants place a lower value on reserves that are less certain. Little capital markets research has focused on the effects of uncertainty on market participants' judgment about financial statement information, but our results suggest the importance of uncertainty on the numerous "point predictions" within the financial statements. Future research might explore the value-relevance of such uncertainty in various assets and liabilities. As an example, several interest rate assumptions are required to calculate pension assets or liabilities under the current disclosure rules. The level of uncertainty associated with these rates should affect investor valuations of the asset or liability. Valuation effects of such uncertainty represent a fruitful direction for additional research.

Appendix

Description of GLS Regression Procedures

In tables 2 and 4, we report results from cross-sectionally regressing estimated oil price response coefficients on various firm-specific SFAS No. 69 disclosures. The relation we wish to estimate is:

$$\Gamma = FB + e, \tag{A1}$$

where Γ is a $J \times 1$ vector (J is the number of firms) containing each firm's oil price response coefficient (γ), F is a $J \times N$ matrix (N is the number of variables) containing the right-hand-side regressors, B is an $N \times 1$ vector containing the cross-sectional regression coefficients, and e is a $J \times 1$ error vector, where individual errors are assumed to be *iid*. However, since Γ is unobservable, it is not possible to estimate equation (A1). Instead, as noted in section I, we estimate Γ via firm-specific time-series market model regressions. In effect, we replace Γ with $\Gamma_* = \Gamma + \delta$, where δ is a vector of estimation error terms. Thus, the cross-sectional regression we estimate is:

$$\Gamma_* = FB + e + \delta, \tag{A2}$$

where e and δ are assumed to be independent.

Even under the assumption that the elements of e are *iid*, it is unlikely that this will be true of δ. In particular, since Γ_* is estimated from firm-specific market model regressions aligned in time and from a single industry, it is reasonable to assume that the estimation errors in δ exhibit both heteroskedasticity and dependence across firms. Under these circumstances, use of OLS in the cross-sectional regressions will yield unbiased estimates of B, but potentially biased standard error estimates, thus affecting any subsequent inferences (see, e.g., Bernard 1987).

In view of this, we employ GLS in estimating and testing equation (A2). This requires a specification (and estimate) of the covariance matrix of error terms in equation (A2). Since *e* and δ are assumed to be independent, the covariance matrix can be expressed as $(\Sigma+\Delta)$, where Σ and Δ are the covariance matrices of *e* and δ, respectively. As noted, we assume that the elements of e are *iid*, thus $\Sigma=\sigma^2 I$, where σ^2 is a scalar variance and *I* is the identity matrix. In contrast, it is likely that the elements of δ are not *iid*. In fact, since δ represents the estimation errors from firm-specific market models, Δ is simply the covariance matrix of estimated oil price response coefficients across the *J* individual firm market model regressions estimated with OLS. With the assumption that market model error terms are *iid* over time (although not necessarily across firms), it is straightforward to verify that the covariance between δ_i and δ_j (i.e., the errors in estimated oil price response coefficients for firms *i* and *j*) is equal to:

$$\mathrm{Cov}(\delta_i,\delta_j)=s_{ij}x_{ij}, \tag{A3}$$

where s_{ij} represents the covariance between market model residuals for firms *i* and *j* (i.e., $s_{ij}=\mathrm{Cov}(\epsilon_{it},\epsilon_{jt})$, where ϵ_{it} and ϵ_{jt} are as defined in equation (3) earlier), and x_{ij} is the (3,3) element in the following 3×3 matrix: $(X_i'X_i)^{-1}(X_i'X_j)(X_j'X_j)^{-1}$ (where X_i is the $T\times 3$ data matrix of time-series market model regressors for firm *i*, and the regressors are in the following order: intercept, market index, value-deflated oil price change). Since s_{ij} is not known, we replace it with the estimated covariance matrix of residuals from the market models. Thus, our inference procedures are justified asymptotically.

Finally, it is also necessary to estimate σ^2, the variance of the e error terms. We do this via a two-stage procedure. First we estimate equation (A2) using OLS and calculate the cross-sectional variance of the resulting residuals. The expected value of the cross-sectional variance is equal to σ^2 plus the sum of all $\mathrm{Cov}(\delta_i,\delta_j)$ terms for $i=1,\ldots,J$ and $j=1,\ldots,J$. Thus, we estimate σ^2 as the difference between the OLS estimated cross-sectional variance term, and the sum of estimated $\mathrm{Cov}(\delta_i,\delta_j)$ terms. (In a few cases the estimated σ^2 was negative and was set at zero.) Given estimates of σ^2 and Δ, we are able to apply GLS to estimating and testing equation (A2).

Although our GLS procedure is similar to approaches taken in previous studies, it differs in several respects. For example, our firm-specific market model regressions do not have identical regressors across firms, as specified in equation (3). Consequently, we are unable to employ portfolio formation or equivalent procedures (Schipper et al. 1987; Sefcik and Thompson 1986) to mitigate dependence and heteroskedasticity in error terms. Further, we explicitly allow for an error term in the cross-sectional regression that is *not* attributable to estimation error in the oil price response coefficients. That is, in equation (A2), we include two error terms, one (*e*) representing errors in the cross-sectional relation (A1) based on true oil price response coefficients, and one (δ) representing errors from estimating oil price response coefficients.

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The Impact of Annual Earnings Announcements on Convergence of Beliefs

Lawrence D. Brown
Jerry C. Y. Han
State University of New York at Buffalo

SYNOPSIS AND INTRODUCTION: One indication of information usefulness is its ability to increase the precision of individuals' estimates of events of interest (FASB 1980; Ijiri and Jaedicke 1966). In this context, earnings reports are useful if they increase the precision of investors' forecasts of future earnings when the latter proxy for the event of interest, future cash flows. The cross-sectional variance of analysts' earnings expectations often is used as a proxy for the unobservable precision of their earnings estimates (Ajinkya and Gift 1985; Brown et al. 1987; Imhoff and Lobo 1992). We show that, when combined with the time-series properties of accounting earnings and prior research in analyst forecasts, Bayesian revisions suggest that year t earnings reports *should*, on average, increase the convergence of analysts' year $t+1$ earnings forecasts. Operationally, we examine whether the information contained in year t earnings decreases the cross-sectional variance of analysts' year $t+1$ forecasts.

Morse et al. (1991) use I/B/E/S Summary data, and conclude that the information contained in year t earnings announcements *increases* the cross-sectional variance of analyst forecasts of year $t+1$. This is a surprising result. One feature of the I/B/E/S Summary data is that they do not contain dates of the analysts' earnings forecasts. Thus, researchers who use these data do not know the set of information upon which the analyst's earnings forecast is based. In contrast to the I/B/E/S Summary data, the I/B/E/S Detail data are precise regarding the date that the individual analyst's earnings forecast entered the I/B/E/S system. We use I/B/E/S Detail data to reexamine the relation between annual earnings announcements and convergence of beliefs.

The authors are grateful to I/B/E/S Inc., for providing the analyst forecast data used in this study. We appreciate the comments of Dosoung Choi, Al Gould, Tom Lechner, Mike Rozeff, the *ad hoc* Associate Editor, and the referees. Jerry Han acknowledges the financial support of the Price Waterhouse fellowship program at SUNY-Buffalo.

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Using the Detail data, we show that the information contained in year *t* earnings decreases the cross-sectional variance of analysts' earnings forecasts of year *t*+1. Moreover, our finding is insensitive to year of study. Using the Summary data, we find that the information contained in year *t* earnings increases the cross-sectional variance of analysts' earnings forecasts of year *t*+1, but this finding *is* sensitive to year of study.

Morse et al. (1991) hypothesize and provide evidence that reduction in variance is less likely to occur when "standardized" surprise is large. Using the Detail data, we show that significant decreases in variance occur for the seven smallest deciles of standardized surprise, and that significant increases in variance occur only for the largest decile. Using the Summary data for the same "window" as the Detail data, we find *no* deciles of standardized surprise associated with significant decreases in variance, and we observe significant increases in variance for the three largest deciles of standardized surprise.

In sum, our results using I/B/E/S Detail data suggest that, on average: (1) annual earnings announcements increase convergence of analysts' forecasts of firms' future earnings; (2) annual earnings announcements decrease convergence only for the largest decile of earnings surprise. In contrast, we do not obtain consistent results with I/B/E/S Summary data.

Key Words: *I/B/E/S forecasts, Detail data, Convergence of beliefs.*

Data Availability: *A list of the sample firms is available from the authors upon request. The analysts' earnings forecast data are proprietary, and can be obtained from Institutional Brokers Estimate System (I/B/E/S) of I/B/E/S Inc. The rest of the data are available from sources identified in the text.*

THE remainder of the article is organized as follows. Section I provides the hypothesis formulation. The methodology is explained in section II. Section III contains evidence that, when using Detail but not Summary data, the information contained in earnings announcements increases convergence of beliefs for the entire sample period, and for all seven years in the sample.[1] Section IV shows that convergence relates to standardized surprise in the direction posited by the Bayesian model, and that these results are reliable only with the Detail data. A summary constitutes section V.

I. Hypothesis Formulation

Morse et al. (1991) model the convergence of beliefs after the year t earnings announcement as negatively related to: (1) the mean and variance of the weight p that analysts assign to their previous year $t+1$ earnings forecasts (denoted by $\bar{p}$ and s_p^2, respectively) and (2) the standardized earnings surprise associated with the earnings announcement, $(\bar{m}-Y)^2/s_m^2$, where $\bar{m}$ and s_m^2 are the mean and variance, respectively, of analyst forecasts (of year $t+1$ earnings) prepared before year t earnings, Y, are announced.

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[1] Using Detail data from Zacks Investment Research, Inc., Stickel (1991) shows that analyst forecasts generally become less dispersed following annual earnings announcements. However, it is impossible to determine if his results differ from those of Morse et al. (1991) because of a different data source (Zacks vs. I/B/E/S) or because of the use of Detail rather than Summary data.

The early literature on the time-series properties of earnings (Albrecht et al. 1977; Ball and Watts 1972; Watts and Leftwich 1977) concluded that annual earnings follow a random walk. If analysts agree that annual earnings follow a random walk, a dollar of "surprise" in year t earnings leads to a dollar of forecast revision in year $t+1$ earnings. In this case, all the weight is placed on the likelihood function, $\bar{p}$ equals 0, and divergence *never* occurs. Recent evidence suggests that annual earnings are an autoregressive process, wherein a dollar of (unstandardized) surprise in year t earnings leads to approximately an 80-cent revision in year $t+1$ earnings (Lipe and Kormendi 1991). If analysts believe that annual earnings follow an autoregressive process, a $\bar{p}$ of 0.2 may be a reasonable approximation of their revision process.[2] Moreover, earnings announcements increase the accuracy of analyst forecasts of future earnings (Abdel-khalik and Espejo 1978; Brown and Rozeff 1979b), and analyst forecast accuracy is positively related to the convergence of analysts' beliefs (Brown et al. 1987; Kross et al. 1990). The joint evidence suggests that the information contained in earnings announcements *should* increase the convergence of analysts' beliefs.

II. Methodology

Unlike the I/B/E/S Summary, the I/B/E/S Detail data enable users to know precisely when individual analysts make earnings forecasts. Thus, the noise in the I/B/E/S Summary data is likely to obscure the impact of annual earnings announcements on belief convergence because researchers cannot use I/B/E/S Summary data to determine when individual analysts revise their forecasts.

We use the I/B/E/S Detail data for the period January 1983 to June 1990. For a firm to be included in the sample, at least three analysts must have revised their forecasts of year $t+1$ earnings in *each* of six time periods—$(-90,-61)$, $(-60,-31)$, $(-30,-1)$, $(+1,+30)$, $(+31,+60)$, and $(+61,+90)$—where day 0 is the annual earnings announcement date as determined by COMPUSTAT.[3] We henceforth refer to these time periods as the six 30-day periods, -3, -2, -1, $+1$, $+2$, and $+3$. The variance of analyst forecasts is calculated for each of these six time periods as a proxy for the convergence/divergence of analysts' beliefs. Because analysts who have updated their forecasts in the $(+1,+30)$ period have recently observed the annual earnings announcement, we assume that their revisions incorporate the earnings information.[4] The number of analysts included in our sample for a given firm is allowed to vary from period to period, and we do not require that the same analysts make revisions in each period. Imposing these additional constraints would severely reduce the sample size, and thus limit the power of the tests.[5]

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[2] Brown and Rozeff (1979a) and Easton and Zmijewski (1989) show that analysts act as if quarterly earnings follow an autoregressive process.

[3] Two-year-ahead forecasts (I/B/E/S data field FY2) are used for time periods prior to the earnings announcement, and one-year-ahead forecasts (I/B/E/S data field FY1) for time periods subsequent to the earnings announcement. The first and sixth time periods may include analyst revisions conditional upon quarterly earnings announcements. To the extent that quarterly earnings announcements increase convergence of beliefs, a conservative bias is introduced that reduces the likelihood of finding annual reports in year t to increase convergence of analysts' year $t+1$ annual earnings forecasts.

[4] An estimate may not be updated if: (1) the analyst does not follow the firm closely, and thus has not considered the consequences of the earnings announcement on forecast revision, or if (2) the analyst follows the

Since precision of variance estimates is positively related to the number of estimates, we require at least three analyst estimates for *each* time period to proxy for divergence of beliefs in the main portion of the study. The 30-day period is selected to be comparable to the (monthly) frequency with which the Summary data are provided. These requirements resulted in 1,510 firm-year observations for 475 firms in the period 1983–89.[6] For ease of comparison with Morse et al. (1991), we use similar procedures to calculate changes in variance and to standardize the data. Changes in variance are defined as the variance in a given 30-day period minus that in the previous 30-day period, stated as a percentage of the variance in the previous 30-day period. For each earnings announcement, changes in variance are standardized to a mean of zero and a standard deviation of 1. This standardization procedure controls for the decline in variance of analyst forecasts as the earnings announcement date approaches (Brown et al. 1985; Crichfield et al. 1978; Elton et al. 1984). Each of the 1,510 firm-year observations consists of five changes in the variance of analysts' forecasts that sum to zero with a standard deviation of 1.

To compare our results with those of Morse et al. (1991), we also examine changes in the variance of analysts' forecasts by using the I/B/E/S Summary data in a similar procedure as for the I/B/E/S Detail data.[7]

III. Empirical Findings: Earnings Announcements and Convergence

Descriptive Statistics

Descriptive statistics of selected variables are reported in table 1. Panel A shows that the mean number of analysts following a sample firm in the month subsequent to the earnings announcement, $AF(+1)$, equals 23.74,[8] and the mean market value of the firm's common equity ($SIZE$) equals $4,718 million. Our sample generally consists of large firms. Small firms are less likely to be represented in our sample because firms are

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firm closely, carefully considers the consequences of the year t earnings announcement, but decides not to update his or her estimate of year $t+1$ earnings. We assume that the first scenario is more descriptive of analyst behavior, but the second scenario also may be valid. The evidence that analysts often update their forecasts after earnings announcements and that the updated forecasts are more accurate than those not updated (Stickel 1989) is consistent with the validity of the first scenario. In conformance with Morse et al. (1991), we focus upon revisions of year $t+1$ annual earnings. Our procedure has the limitation that analysts may revise their forecasts of earnings for years other than $t+1$ (Brown et al. 1985).

[5] We examined the sensitivity of our results to relaxation of the requirement that at least three analysts revise their forecasts in each of six time periods by specifying four time periods instead. Further, we examined the sensitivity of our results for a subsample of observations wherein the forecast revisions are made by the *same* analysts. The results were qualitatively similar to those presented and are available from the authors upon request.

[6] There were four observations in 1990, which are classified as 1989 for parsimony.

[7] For similarity to Morse et al. (1991), we conducted analyses using eight months of I/B/E/S Summary data—the three months before and the five months after the earnings announcement. The results are qualitatively similar to those reported in the text with six months of I/B/E/S Summary data.

[8] Analyst-following during other periods surrounding the annual earnings announcement remains stable and is not reported.

Table 1
Descriptive Statistics of Selected Variables
(n=1,510)

Panel A. General Variables:

			Percentile				
	Mean	*Standard Deviation*	*0.05*	*0.25*	*0.50*	*0.75*	*0.95*
AF(+1)	23.74	7.20	13.00	19.00	23.00	28.00	37.00
SIZE	4,718.61	7,418.63	484.97	1,270.36	2,504.93	5,102.60	16,474.40
REV(−3)	9.29	5.10	3.00	6.00	8.00	12.00	19.00
REV(−2)	7.14	3.63	3.00	4.00	6.00	9.00	14.00
REV(−1)	6.55	3.45	3.00	4.00	6.00	8.00	13.00
REV(+1)	10.21	5.36	4.00	6.00	9.00	13.00	20.00
REV(+2)	8.72	4.28	3.00	6.00	8.00	11.00	17.00
REV(+3)	9.13	4.81	3.00	6.00	8.00	11.00	18.00

Panel B. Variance Changes With I/B/E/S Detail Data:

			Percentile				
	Mean	*Standard Deviation*	*0.05*	*0.25*	*0.50*	*0.75*	*0.95*
CVAR(−3,−2)	0.07	0.89	−0.93	−0.56	−0.35	0.73	1.76
CVAR(−2,−1)	0.21	0.97	−0.95	−0.57	−0.20	1.24	1.78
CVAR(−1,+1)	−0.23	0.83	−1.11	−0.73	−0.51	−0.04	1.73
CVAR(+1,+2)	−0.01	0.86	−0.95	−0.60	−0.37	0.46	1.75
CVAR(+2,+3)	−0.04	0.85	−0.97	−0.60	−0.40	0.41	1.74

Panel C. Variance Changes With I/B/E/S Summary Data:

			Percentile				
	Mean	*Standard Deviation*	*0.05*	*0.25*	*0.50*	*0.75*	*0.95*
CVAR(−3,−2)	0.03	0.85	−1.32	−0.55	−0.07	0.67	1.56
CVAR(−2,−1)	0.03	0.83	−1.32	−0.57	−0.05	0.64	1.52
CVAR(−1,+1)	0.08	0.92	−1.39	−0.62	0.00	0.77	1.66
CVAR(+1,+2)	−0.08	0.92	−1.46	−0.77	−0.23	0.61	1.61
CVAR(+2,+3)	−0.06	0.91	−1.47	−0.74	−0.16	0.60	1.62

Note: The variables are defined as follows:

AF(+1)=Number of analysts following a firm during the month subsequent to the announcement of year *t* earnings.

SIZE=Market value of outstanding common stock at the end of the current fiscal year (in millions).

REV(n)=Number of analysts revising their forecasts for year *t*+1 during period n according to I/B/E/S Detail data. Each period reflects a 30-day interval beginning with (−90,−61) (n=−3). The announcement date of year *t* earnings (day 0) is excluded, so n=−1 and n=+1 are (−30,−1) and (+1,+30), respectively.

CVAR(n1,n2)=Variance change is calculated as the variance in period n2 minus the variance in period n1, stated as a percentage of the variance in period n1. For I/B/E/S/ Detail data, each period reflects a 30-day interval beginning with (−90,−61) (n=−3). The announcement date of year *t* earnings (day 0) is excluded so n=−1 and n=+1 are (−30,−1) and (+1,+30), respectively. For I/B/E/S Summary data, the time periods are determined by the I/B/E/S/ Summary tape, where −1 (+1) is the month prior (subsequent) to the earnings announcement. Each firm's changes are standardized to mean zero and s.d. 1.

required to have at least three revised forecasts (*REV*) in each of the six 30-day periods, −3, −2, −1, +1, +2, and +3. As in Brown et al. (1985) and Stickel (1989), it is evident that financial analysts are considerably more active in revising their forecasts for year $t+1$ immediately after the year t earnings announcement rather than immediately prior to it. More specifically, the mean number of forecast revisions for the following year's earnings declines from 9.29 in period −3 to 7.14 in period −2 to 6.55 in period −1. *REV* increases substantially to 10.21 during the 30-day period immediately following the earnings announcement, and it remains at a relatively high level afterward. This finding is consistent with the evidence that analysts use current earnings information to revise their forecasts of future earnings (Brown and Rozeff 1979a; Easton and Zmijewski 1989; Givoly 1985).

Variance of analyst forecasts is calculated for each of the six test periods on the basis of the forecasts made during the specific period. These are presented for Detail and Summary data in panels B and C, respectively. The change in variance (*CVAR*) is calculated according to the standardization procedure described above, and yields five variance changes for each firm for (−3,−2), (−2,−1), (−1,+1), (+1,+2), and (+2,+3). The mean values of *CVAR* for both Detail and Summary data exceed the median values in all five periods, which suggests that the *CVAR* distribution is skewed to the right. To avoid drawing erroneous conclusions based on results dominated by outliers, we use a nonparametric ranking procedure to test for analyst forecast convergence. For each earnings announcement, we calculate the percentage change of analyst forecast variance for each of the six adjacent periods. This procedure results in the aforementioned five variance changes, with rank 1 (5) assigned for the largest (smallest) variance decrease relative to the variance changes in the other four adjacent periods. Firms in the rank 1 portfolio are assumed to have negative standardized variance changes. Although a variance increase (i.e., divergence of beliefs) in a specific period may receive a rank of 1 when the variance *increase* is lower than that in the other adjacent periods, our results suggest that this is atypical with our sample observations. More specifically, 973 of the 1,510 observations (64.4 percent) show variance decreases in the (−1,+1) period, and the median percentage variance change during the period is −42.81 percent. A sample mean rank significantly lower than the expected rank of 3 (i.e., (1+5)/2) in the (−1,+1) period is assumed to indicate an overall increase of convergence (i.e., decrease of variance) associated with the annual earnings announcement. For comparison with Morse et al. (1991), we also present results with the unranked but standardized variance change (*CVAR*) data.

Principal Results

Table 2 displays results with all years combined for the Detail and Summary data (in panels A and B, respectively). Table 2 contains the percentage of the time that the observations take on the ranks 1–5, where 1 is the largest increase in convergence (i.e., the largest decrease in variance). The percentages across each of the rows and down each of the columns sum to 100 percent. Each row/column entry equals 20 percent under the null hypothesis that the ranks are independently distributed across the five adjacent 30-day periods.

The alternative hypothesis is that earnings announcements affect the variance of analyst forecasts, and it is evident from the Detail data that the period surrounding the earnings announcement is associated with the largest increase in convergence. More specifically, 35.8 percent of the observations in the (−1,+1) period in panel A exhibit

Table 2

Distribution of Percentage Changes in Variances of Analyst Forecasts Around Annual Earnings Announcements: All Years Combined

Panel A. Percentage of Firms in Each Period by Rank of Variance Change When Using I/B/E/S Detail Data:

Rank of Variance Change[b]	*Adjacent Periods Relative to Annual Earnings Announcement*[a]				
	(−3,−2)	(−2,−1)	(−1,+1)	(+1,+2)	(+2,+3)
1 (Most Convergence)	14.5	16.4	35.8	17.9	15.4
2	19.6	16.4	17.8	21.4	24.8
3	22.3	19.2	18.5	19.1	20.9
4	21.1	19.7	14.3	23.6	21.3
5 (Least Convergence)	22.5	28.3	13.6	18.0	17.6
Mean Excess Rank[c]	0.17*	0.27*	−0.48*	0.02	0.01
t-value on Excess Ranks	(4.97)	(7.32)	(−12.94)	(0.66)	(0.29)
Mean CVAR[d]	0.07*	0.21*	−0.23*	−0.01	−0.04
t-value on CVAR	(3.10)	(8.27)	(−10.74)	(−0.46)	(−1.77)

Panel B. Percentage of Firms in Each Period by Rank of Variance Change When Using I/B/E/S Summary Data:

Rank of Variance Change[b]	*Adjacent Periods Relative to Annual Earnings Announcement*[a]				
	(−3,−2)	(−2,−1)	(−1,+1)	(+1,+2)	(+2,+3)
1 (Most Convergence)	14.6	15.2	17.0	24.2	24.6
2	17.4	17.3	18.7	19.2	17.4
3	23.4	23.8	18.9	19.5	18.8
4	23.9	25.2	22.6	19.1	21.1
5 (Least Convergence)	20.7	18.5	22.8	17.9	18.1
Mean Excess Rank[c]	0.13*	0.09*	0.11*	−0.17*	−0.15*
t-value on Excess Ranks	(3.80)	(2.65)	(3.01)	(−4.78)	(−4.21)
Mean CVAR[d]	0.03	0.03	0.08*	−0.08*	−0.06*
t-value on CVAR	(1.53)	(1.54)	(3.42)	(−3.57)	(−2.71)

[a] For I/B/E/S Detail data, each period reflects a 30-day interval beginning with (−90,−61) ($n=-3$). The announcement date of year t earnings (day 0) is excluded, so $n=-1$ and $n=+1$ are (−30,−1) and (+1,+30), respectively. For I/B/E/S Summary data, the time periods are determined by the I/B/E/S Summary tape, and −1 (+1) is the month prior (subsequent) to the earnings announcement. The six periods are used to derive five adjacent periods of changes in variance.

[b] Rank 1 (rank 5) represents the largest (smallest) decrease in the variance of analyst earnings forecasts; the ranks are determined by comparing the five changes in variance in the six periods relative to the earnings announcement. The numbers represent the percentage of the time that the adjacent periods relative to the earnings announcement take that rank. The percentages across the rows and columns add to 100.0.

[c] Excess rank is calculated as the difference between rank value and the expected rank of 3. A negative (positive) excess rank indicates increase (decrease) in convergence.

[d] CVAR (variance change) is calculated as the variance in period $n2$ minus the variance in period $n1$, stated as a percentage of the variance in period $n1$. Each firm's variance changes are standardized to mean zero and s.d. 1.

* Significant at the 0.01 level, two-tailed test.

the largest variance decrease (rank 1), and only 13.6 percent exhibit the smallest variance decrease (rank 5). These are, respectively, the largest and smallest percentages in the five adjacent 30-day periods in the table. The table also presents mean excess ranks (mean ranks minus the expected rank of 3), mean variance changes (*CVAR*), and their respective *t*-values. Both *t*-test results reveal significant variance decreases in the $(-1, +1)$ period (the respective *t*-values are -12.94 and -10.74). Thus, the Detail data reveal that annual earnings announcements do increase the convergence of analyst beliefs.

In conformance with Morse et al. (1991), panel B shows that the period surrounding the earnings announcement is associated with a decrease in convergence when the Summary data are used. More specifically, only 17 percent of the observations in the $(-1,+1)$ period exhibit the largest variance decrease (rank 1), and 22.8 percent exhibit the smallest variance decrease (rank 5). Moreover, both *t*-test results reveal significant variance increases in the $(-1,+1)$ period (i.e., the respective *t*-values are 3.01 and 3.42). When the sample period is extended to several months after the earnings announcement, variance decreases are evident. More specifically, both *t*-test results reveal significant variance decreases for the $(+1,+2)$ and $(+2,+3)$ periods. Thus, the Summary data appear to obscure the influence of annual earnings announcements on the convergence of analysts' beliefs.

Yearly Analysis

Our results may be driven by one or two years, and may not be generalizable. To examine this issue, we present *t*-values of excess ranks for the Detail and Summary data in panels A and B of table 3 for each of the seven years, 1983–89.[9] The results with the Detail data are consistent across years. The mean excess rank of changes in variance in the $(-1,+1)$ period is negative in all seven years, and the *t*-values are significant in six of the seven years. In contrast, the results with the Summary data are inconsistent across years. The mean excess rank of changes in variance in the $(-1,+1)$ period is negative in two years, positive in five others, and the *t*-values are significant (positive) in only three years. Moreover, the *t*-values in the $(+1,+2)$ and $(+2,+3)$ periods are significant (negative) in only three years. We conclude that the results with Detail data are generalizable, whereas those with Summary data are not.[10]

IV. Empirical Findings: Earnings Surprise and Convergence

The Bayesian model suggests that larger standardized surprises are more likely to cause divergence. We define standardized surprise as $(\bar{m}-Y)^2/s_m^2$, where $\bar{m}$ and s_m^2 are the mean and variance, respectively, of analyst forecasts (of year $t+1$ earnings) prepared during $(-30,-1)$, where day 0 is the year t earnings announcement date and Y is the earnings announced on day 0. To examine the empirical relation between standardized surprise and convergence, we rank the standardized surprises of the 1,510 sample firms from lowest to highest, form ten equal-sized portfolios, and examine changes in variance during the $(-1,+1)$ period. Table 4 presents the results with Detail data. The smallest and largest portfolios have mean standardized surprises of 0.16 and 627.99,

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[9] We obtained qualitatively similar results using actual change in variance (*CVAR*) rather than ranks. For simplicity, we do not present these results, but they are available upon request.

[10] Our results may be driven by observations for which variance change estimates are especially precise, namely those with a large number of revisions used to determine variance changes. To test whether the results are sensitive to the number of revisions, we divide the sample ($n=1{,}510$) into four groups—those with between three and six, seven and nine, ten and thirteen, and more than thirteen forecast revisions in the month immediately following the annual earnings announcement. The results are consistent across the four groups.

Table 3
Mean Excess Ranks of Changes in Variances of Analyst Forecasts Around Annual Earnings Announcements Conditional on Year
(*t*-values in parentheses)

Panel A. Mean Excess Ranks With I/B/E/S Detail Data:[b]

		Adjacent Periods Relative to Annual Earnings Announcement[a]				
Year	N	(−3,−2)	(−2,−1)	(−1,+1)	(+1,+2)	(+2,+3)
1983	136	−0.02 (−0.19)	0.18 (1.52)	−0.29** (−2.29)	0.19 (1.60)	−0.06 (−0.50)
1984	228	0.25* (2.87)	0.44* (4.58)	−0.60* (−6.57)	−0.07 (−0.79)	−0.03 (−0.30)
1985	229	0.17** (2.03)	0.23** (2.46)	−0.55* (−5.91)	0.12 (1.26)	0.02 (0.20)
1986	237	0.05 (0.53)	0.09 (0.91)	−0.13 (−1.35)	−0.01 (−0.14)	0.00 (0.05)
1987	254	0.19** (2.17)	0.13 (1.42)	−0.36* (−3.89)	−0.09 (−1.07)	0.13 (1.63)
1988	215	0.30* (3.25)	0.46* (4.69)	−0.72* (−7.72)	−0.06 (−0.67)	0.02 (0.26)
1989	211	0.20** (2.14)	0.38* (3.91)	−0.69* (−6.92)	0.18** (1.98)	−0.07 (−0.79)

(*Continued*)

respectively. Results of *t*-tests on mean excess ranks and mean changes in variance also are presented. Finally, the percentages of firms in each portfolio with relative increases in variance, when using the ranked and variance change (*CVAR*) data, respectively, are presented.

The results for portfolio 1 (the firms with the smallest standardized surprises in earnings) reveal a significant decrease in variance when using either ranks (*t*-value = −9.33) or actual variance changes (*t*-value = −8.84). As expected, the percentage of firms in portfolio 1 with variance increases is low, when using either ranks (13.91 percent) or changes in variance (14.57 percent). Indeed, significant variance decreases are observed for the seven portfolios with the smallest standardized surprises in earnings. A variance increase is observed, at most, for 32.45 and 24.50 percent of the firms in the seven smallest deciles when using ranks and variance changes, respectively. (See the percentage of positive excess rank for portfolios 6 and 7.) There is no significant change in variance for the eighth and ninth deciles, and the percentage positive rank pertains, at most, to 37.09 percent of the firms in these deciles. A significant increase in variance is observed only for portfolio 10, which has a mean standardized surprise of 627.99. However, even in this portfolio, variance increases occur only in 58.28 and 50.33 percent of the firms, when using ranks and variance changes, respectively. The Spearman rank correlations between standardized surprise and mean excess rank, percentage of positive excess rank, mean change in variance, and percentage of positive *CVAR*, respectively, are 0.976, 0.939, 0.964, and 0.879. Thus,

Table 3—*Continued*

Mean Excess Ranks of Changes in Variances of Analyst Forecasts Around Annual Earnings Announcements Conditional on Year

(t-values in parentheses)

Panel B. Mean Excess Ranks With I/B/E/S Summary Data:[b]

		Adjacent Periods Relative to Annual Earnings Announcement[a]				
Year	N	(−3,−2)	(−2,−1)	(−1,+1)	(+1,+2)	(+2,+3)
1983	136	0.06 (0.47)	−0.11 (−1.01)	0.39* (3.40)	−0.19 (−1.71)	−0.14 (−1.17)
1984	228	0.25* (2.96)	0.01 (0.08)	0.15 (1.70)	−0.24* (−2.59)	−0.17 (−1.80)
1985	229	−0.01 (−0.13)	0.08 (0.99)	0.20** (2.25)	−0.02 (−0.23)	−0.25* (−2.69)
1986	237	0.07 (0.86)	0.13 (1.54)	0.28* (2.97)	−0.29* (−3.20)	−0.19** (−2.12)
1987	254	0.16 (1.94)	0.12 (1.52)	−0.14 (−1.63)	−0.11 (−1.20)	−0.03 (−0.39)
1988	215	0.02 (0.24)	−0.00 (−0.02)	0.03 (0.35)	−0.00 (−0.05)	−0.05 (−0.46)
1989	211	0.33* (3.47)	0.32* (3.52)	−0.04 (−0.37)	−0.37* (−4.03)	−0.24** (−2.48)

[a] For I/B/E/S Detail data, each period reflects a 30-day interval beginning with (−90,−61) (n = −3). The announcement date of year t earnings (day 0) is excluded, so n = −1 and n = +1 are (−30,−1) and (+1,+30), respectively. For I/B/E/S Summary data, the time periods are determined by the I/B/E/S Summary tape, and −1 (+1) is the month prior (subsequent) to the earnings announcement. The six periods are used to derive five adjacent periods of changes in variance.

[b] Rank 1 (rank 5) represents the largest (smallest) decrease in the variance of analyst earnings forecasts; the ranks are determined by comparing the five changes in variance in the six periods relative to the earnings announcement. Excess rank is calculated as the difference between rank value and the expected rank of 3. A negative (positive) excess rank indicates increase (decrease) in convergence.

* Significant at the 0.01 level, two-tailed test.

** Significant at the 0.05 level, two-tailed test.

there exists a very large positive correlation between standardized surprise and increase in variance.[11]

Table 5 presents results with Summary data in a manner comparable to table 4. Three time periods that exhibit significant results in table 2 are examined for the relation between standardized surprise and changes in variance of analysts' earnings forecasts, namely (−1,+1), (+1,+2), and (+2,+3). For simplicity, results are

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[11] We also tested whether the relation between standardized surprise and variance increase is sensitive to the number of revisions used to estimate the degree of convergence. The sample firms are grouped into ten portfolios according to the magnitude of standardized surprise. Firms in each portfolio are segmented into four groups by the number of forecast revisions made in the month immediately following the annual earnings announcement, and six, nine, and thirteen revisions are used as cutoffs. Spearman rank correlations between standardized surprise and variance changes are calculated for each of the four groups. The results are robust across the groups and are available upon request.

Table 4
Portfolio Analysis of Relation Between Standardized Surprise and Change in Variance of Analyst Forecasts for the Time Period (−1,+1) with I/B/E/S Detail Data

(t-values in parentheses)

Portfolio	*Mean Standardized Surprise*	*Mean Excess Rank*[a]	*% Positive Excess Rank*[b]	*Mean CVAR*[c]	*% Positive CVAR*[d]
1 (Smallest)	0.16	−0.96* (−9.33)	13.91	−0.47* (−8.84)	14.57
2	0.95	−0.93* (−8.49)	17.22	−0.45* (−7.88)	19.21
3	2.26	−0.84* (−8.03)	16.56	−0.44* (−7.99)	15.23
4	4.01	−0.92* (−9.00)	16.56	−0.47* (−9.17)	13.25
5	6.77	−0.83* (−8.02)	17.22	−0.44* (−8.55)	16.56
6	12.68	−0.37* (−3.12)	32.45	−0.21* (−3.06)	22.52
7	26.23	−0.32* (−2.84)	32.45	−0.20* (−3.20)	24.50
8	55.86	−0.09 (−0.73)	37.09	−0.02 (−0.25)	32.45
9	138.78	−0.13 (−1.04)	37.09	0.01 (0.18)	33.77
10 (Largest)	627.99	0.60* (5.52)	58.28	0.38* (4.61)	50.33
Spearman rank correlation:		0.976*	0.939*	0.964*	0.879*

Note: The sample consists of 1,510 firms grouped into ten equal-sized portfolios according to the magnitude of their standardized surprises, defined as $(m-Y)^2/s_m^2$, where m is the mean of analyst forecasts (of year $t+1$ earnings) prepared during (−30, −1), day 0 is the year t earnings announcement date, Y is the earnings announced on day 0, and s_m^2 is the variance of analyst forecasts (of year $t+1$ earnings) prepared during (−30, −1). Portfolio 1 (10) contains the 151 firms with the smallest (largest) standardized surprises.

[a] Rank 1 (rank 5) represents the largest (smallest) decrease in the variance of analyst earnings forecasts, with ranks determined by comparing the five changes in variance in the six adjacent periods relative to the earnings announcement. Excess rank is calculated as the difference between rank value and the expected rank of 3. A negative (positive) excess rank indicates increase (decrease) in convergence.

[b] The percentage of firms in each portfolio with rank greater than the expected rank of 3.

[c] Mean *CVAR* is the average change in variance when using the standardization procedure described in the text.

[d] The percentage of firms in each portfolio with variance increases (i.e., positive *CVAR*) when using the standardization procedure described in the text.

* Significant at the 0.01 level, two-tailed test.

presented for mean excess ranks, but similar results, available upon request, are obtained by using mean *CVAR*. In table 2, a significant variance increase in the (−1,+1) period was shown. In table 5 a significant variance increase is apparent in the (−1,+1) period for the three largest deciles, and there is no significant variance

Table 5
Portfolio Analysis of Relation Between Standardized Surprise and Change in Variance of Analyst Forecasts with I/B/E/S Summary Data
(*t*-values in parentheses)

Portfolio	*Mean Standardized Surprise*	*Mean Excess Rank* (−1,+1)	(+1,+2)	(+2,+3)
1 (Smallest)	0.11	−0.13 (−1.15)	−0.06 (−0.49)	−0.43* (−3.56)
2	0.67	−0.10 (−0.90)	−0.16 (−1.34)	−0.23** (−1.98)
3	1.63	0.01 (0.09)	−0.15 (−1.29)	−0.08 (−0.67)
4	3.12	−0.06 (−0.50)	−0.16 (−1.34)	−0.21 (−1.75)
5	5.39	−0.14 (−1.24)	−0.37* (−3.26)	0.02 (0.18)
6	8.36	0.20 (1.84)	−0.36* (−3.18)	−0.14 (−1.14)
7	12.53	0.19 (1.75)	−0.23** (−2.03)	−0.06 (−0.48)
8	19.84	0.40* (3.41)	0.09 (0.73)	−0.17 (−1.57)
9	36.50	0.30* (2.74)	−0.13 (−1.17)	−0.06 (−0.51)
10 (Largest)	221.67	0.41* (3.70)	−0.21 (−1.88)	−0.19 (−1.78)
Spearman rank correlation:		0.842*	−0.116	0.456

Note: The sample consists of 1,510 firms grouped into ten equal-sized portfolios according to the magnitude of their standardized surprises, defined as $(\bar{m}-Y)^2/s_{\bar{m}}^2$, where $\bar{m}$ is the mean of I/B/E/S Summary forecasts (of year $t+1$ earnings) prepared immediately before year t earnings, Y, is announced and $s_{\bar{m}}^2$ is the variance of I/B/E/S Summary forecasts (of year $t+1$ earnings) prepared before the year t earnings announcement. Portfolio 1 (10) contains those 151 firms with the smallest (largest) standardized surprises. Rank 1 (rank 5) represents the largest (smallest) decrease in the variance of analyst earnings forecasts, with ranks determined by comparing the five changes in variance in the six adjacent periods relative to the earnings announcement. Excess rank is calculated as the difference between rank value and the expected rank of 3. A negative (positive) excess rank indicates increase (decrease) in convergence.

* Significant at the 0.01 level, two-tailed test.

** Significant at the 0.05 level, two-tailed test.

decreases in *any* deciles. This latter result is inconsistent with the implication of Bayesian theory that convergence of analyst forecasts is likely to occur. A significant variance decrease in the (+1,+2) and (+2,+3) periods is shown in table 2 with Summary data. For the (+1,+2) period, only three deciles (i.e., the fifth through seventh smallest) exhibit significant variance decreases in table 5. Similarly, for the (+2,+3) period, there are only (the smallest) two deciles of significant variance decreases. The Spearman rank correlation between standardized surprise and change in variance of analyst forecasts is insignificant in both periods. These insignificant correlations are inconsistent with the implication of the Bayesian model that change in variance is related to the magnitude of standardized surprise.

In sum, the results when using the Detail data are consistent with implications of the Bayesian model that convergence of analyst forecasts generally occurs, and that earnings surprise is likely to be substantial when divergence does occur. In contrast, the results when using the Summary data are inconsistent with these implications of the Bayesian model.[12] We interpret our results as indicating that the Detail data are more appropriate than the Summary data for the purpose of examining the effect of earnings announcements on convergence of beliefs.[13]

V. Summary

Bayesian theory, when combined with the time-series properties of accounting earnings and prior research in analyst forecasts, suggests that annual earnings announcements *should* increase the convergence of analysts' forecasts of future earnings. Morse et al. (1991) used I/B/E/S Summary data and found the opposite. Using I/B/E/S Detail data, we show that annual earnings announcements *do* increase the convergence of analyst expectations of next year's earnings for all seven years of study. We show that convergence is less likely to occur when standardized earnings surprise is large, which is consistent with the Bayesian model. More specifically, significant divergence pertains only to the largest decile of standardized surprise. Using I/B/E/S Summary data, we do not obtain consistent evidence regarding the effect of earnings announcements on convergence of beliefs. It appears that I/B/E/S Summary data obscure this effect.

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[12] When there is a significant relation between the magnitude of standardized surprise and convergence of analyst forecasts (i.e., period [−1,+1] in table 5), convergence of analysts' earnings forecasts does not occur (i.e., period [−1,+1] in table 2, panel B). When convergence of analysts' earnings forecasts does occur (i.e., periods [+1,+2] and [+2,+3] in table 2, panel B), a significant relation between standardized surprise and convergence of forecasts does not exist (i.e., periods [+1,+2] and [+2,+3] in table 5).

[13] Ideally, all analyst forecasts are made at the exact same point in time, so that a variance can be calculated with forecasts of identical timeliness. This ideal is unobtainable but is better approximated with Detail than Summary data.

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BOOK REVIEWS

Shane R. Moriarity, Editor

Editor's Note: Two copies of books for review should be sent to Professor Shane Moriarity, School of Accounting, University of Oklahoma, Norman, OK 73019. The policy of the *Review* is to publish only those reviews solicited by the Book Review Editor. Unsolicited reviews will not be accepted.

GEORGE LISLE, Editor, *Encyclopaedia of Accounting* (Osaka: Nihon-Shoseki, Ltd., 1991, originally published Edinburgh: William Green & Sons, 1903–1907, pp. 4,076, 8 vols., $1,520 for the set).

For students of the practice of accounting and auditing in the United Kingdom at the turn of the century, as well as of the legal and commercial environment of the time, this monumental, eight-volume *Encyclopaedia of Accounting* is an indispensable reference work.

George Lisle, a Scottish chartered accountant and actuary, conducted the entire enterprise. He edited and contributed to the first six volumes of the encyclopedia, which were published in 1903–04, and he was the editor and principal author of the two supplementary volumes entitled *Forms and Precedents for Accountants*, which made their appearance in 1906–07. Lisle was also the author or co-author of three accounting textbooks, one of which, *Accounting in Theory and Practice* (Edinburgh: William Green & Sons, 1899), was lauded by Hatfield as "perhaps the best single volume treating the entire subject which has appeared in English" (1909, 33).

In the first six volumes of the encyclopedia, many of the major essays on bookkeeping, accounting, and auditing were written by leading commentators of the day, including Lawrence R. Dicksee, Francis W. Pixley, Sidney S. Dawson, Edwin Guthrie, Arthur F. Whinney, William Annan, John Mann, Jr., Richard Brown, and John Row-Fogo, as well as by Lisle himself. Th. Limperg, Jr. contributed a note on "Accountants Abroad," in which he described how the fledgling Dutch profession had followed "the good example of England" (vol. 1, 19). Numerous lengthy articles treat the record-keeping and financial reports peculiar to different lines of business (e.g., flour mills, gas-works, and stockbrokers). Of particular interest are the many thoughtful articles contributed by authorities from neighboring disciplines dealing with the law, economics, finance, taxation, mathematics, statistics, and insurance. Lisle wrote all of the hundreds of shorter entries.

Hatfield characterized the encyclopedia as "A most valuable work of [the] highest scientific standard" (1909, 33), a judgment with which I concur. Many of the longer essays rank as scholarly dissertations, reflecting painstaking research and a commendable attention to detail. In not a few essays, the historical line is nicely developed.

The eight volumes of the encyclopedia received favorable reviews in *The Accountants' Magazine*, the monthly journal of Scottish chartered accountants, but, unaccountably, the encyclopedia was not reviewed in either *The Accountant* or *The Journal of Accountancy*.

Several of the major essays reward the non-specialist with interesting insights. Dicksee, in a 30-page disquisition on "Auditing," asserted that "for practical purposes almost every set of audited accounts is, to a greater or smaller extent, a statement of opinion rather than a statement of fact" (vol. 1, 169). Dicksee viewed the auditor as virtually a censor: "The auditor is naturally not likely to be better informed of the facts than the accounting parties themselves; but as an expert in accounts, he may have special knowledge that will enable him to usefully criticise their opinions, and if need be to correct them" (p. 169).

In a 13-page discussion of "Balance Sheets," Lisle speculated on the reason why, in the UK (alone among all countries), liabilities appeared on the left side of the balance sheet, and assets on the right side. "Theoretically," Lisle wrote, assets, which carry debit balances, should appear on the left side. He attributed this eccentricity to "the influence of the forms given in Acts of Parliament, chiefly the Companies Act, 1862, which must have been prepared by those unacquainted with the theory of accounts!" (vol. 1, 205). In an adjoining table, Lisle showed that almost all authors of works on bookkeeping published prior to 1860 showed assets on the left side (p. 207). He claimed that "the Continental or Scotch form," with the assets on the left, "is founded on correct principles," which, he maintained, "should become universal"[1] (p. 206). I have always been intrigued by this UK oddity, which came to have an influence on the formats of balance sheets in other countries of the British Empire. I had not realized that the Scots generally followed Continental practice, with only the English paying attention to the forms suggested by the 1862 Act. (Finally, in 1981, when UK law was adapted to the EC's Fourth Directive, Parliament declared, in effect, that assets could no longer be shown on the right, or at the bottom, of the balance sheet.)

Both Guthrie, in a 19-page essay on "Depreciation" (vol. 2, 360), and Dawson, in a six-page discussion of "Reserves and Reserve Funds" (vol. 5, 486), found it necessary to counsel against the deliberate overstatement or understatement of profit by the use of accounting artifices. Creative accounting is hardly a recent invention.

Guthrie raised the question of the depreciation of goodwill, which, he said, posed the following conundrum:

> One great difficulty of the situation is, that the less able the business may be to bear the charge of the gradual redemption of a goodwill, the more important it is that provision should be made for redemption. On the other hand, the value of a goodwill may increase and the business so prosper, that the greater the ability to provide for the redemption of goodwill the less the necessity is there to do so (vol. 2, 372).

Some 20 years later, Couchman (1924, 138) was more pointed: "To put it briefly, if you can write it down, you need not; if you cannot, you should!"

Latter-day defenders of the view that goodwill should not be amortized against profits will find historical support in Dawson's vision of proper accounting. In a 12-page excursion on "Goodwill," he argued that, whether a company were to write off goodwill immediately or to depreciate it over a period of years, the charge should not be made against profits, but should be treated as an appropriation of profits (vol. 3, 204–05). Agreeing with Guthrie, Dawson contended that the possibility of eliminating goodwill against profits "may afford the best proof of its value" (p. 204). He suggested that the company's "directors and shareholders may wisely agree to forego a portion of the 'legally divisible profit' in order to reduce or eliminate the amount at which the goodwill stands on the books, and so enhance the financial position of the company, for, notwithstanding the reduction of the book value of the goodwill, the actual value, if any, is unaffected (at all events not reduced) by such a proceeding" (p. 205). He reported that some companies had written off the entirety of their goodwill by an appropriation of profits, but their balance sheets had, from time to time, displayed the original cost of goodwill in an inner column on the asset side.

In a bibliographical note entitled "Book-keeping: Literature," Brown presented an impressive list of the treatises on bookkeeping published through the end of the seventeenth century, as well as a compilation of English works from the beginning of the eighteenth century onward. He vouched that "there is no published list known to the writer which contains even half the number of the books here mentioned" (vol. 1, 494).

Lisle's encyclopedia is a treasure of "period pieces" on accounting. Yet I question the publisher's judgment in establishing a price of $1,520 for the eight-volume set. To be sure, the encyclopedia is a precious resource for economic and accounting historians with a special interest in the United Kingdom at the turn of the century. But how many such researchers, or their libraries, will pay the price? (Copies can be borrowed on inter-library loan. In the United States alone, 11 libraries hold the encyclopedia, and the Library of Congress possesses a master microform from which copies could be made.) For the generalist reader whose interest is mainly in the major essays on bookkeeping, accounting, and auditing, these were reprinted in 1978 in a volume edited by Brief, which is currently held by 70 U.S. libraries.

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[1] Dicksee (1907, 269) wrote that "there was good reason underlying this apparent anomaly." He attributed the asset-liability transposition to the curious balance sheet that emerged upon the reopening of the Ledger following the end-of-period balancing and closing of the Ledger under the Italian system of bookkeeping, which, he said, was still being used in some old-fashioned merchants' houses.

I really doubt that university libraries, with budgets already overrun by the explosion in the number of academic journals and their bloated subscription rates, could justify expenditure of a princely sum for the purchase of Lisle's excellent encyclopedia. One hopes that the publisher will reassess the price-elasticity of demand, and will (at least) halve the price, so that a larger number of interested purchasers might be brought into the market.

The volumes are handsomely bound and are printed on heavy paper. Basil Yamey has supplied a nice Introduction.

STEPHEN A. ZEFF
Professor of Accounting

Rice University

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RICHARD MATTESSICH, *Accounting Research in the 1980s and Its Future Relevance* (Vancouver: The Canadian Certified General Accountants' Research Foundation, 1991, pp. xi, 277, C$22.00, paper).

This monograph, the seventeenth in a series sponsored by the Canadian Certified General Accountants' Research Foundation (CCGARF), is a supplementary volume that updates the author's 1984 book *Modern Accounting Research: History, Survey, and Guide*. The strong acceptance of the original volume (the seventh in the CCGARF series) led to its reprinting in 1989. It is likely that this new effort will find just as broad and robust a following.

Mattessich notes that the decade of the '80s produced a very rich but "bewildering variety" of research outputs in accounting. Claiming that these outputs are difficult to adequately survey, he attempts with this monograph to flesh out the essential patterns in what he sees as a "kaleidoscope of research interests." The book is intended as an anthology—as distinct from a readings book—that presents a major integrating overview followed by a small number (in this case six) of reprinted articles. The reprinted pieces were chosen on the basis of the strength of their contribution to the essential features and trends that characterized contemporary accounting research in the 1980s.

In reality the monograph consists of "two books in one": a lengthy commentary on the growth, changing level of sophistication, and future direction of accounting research; and the six article reprints. Dealing with the reprinted materials first, it can be noted that the six articles are from four different major accounting journals. Five overarching themes of accounting research in the 1980s are intended to be represented here. These themes are: (1) revisions of the role/application of management accounting, (2) implications of behavioral and organizational accounting, (3) positive theory and financial accounting research, (4) advances in income measurement, and (5) the influences of agency-contract theory on accounting. The financial accounting theory area is represented by two papers, each of which is an attempt to provide a synthesis of extant conceptual work related to the topic of stock valuation and accounting numbers. The three themes of management accounting, behavioral accounting, and agency relationships are covered by broad survey articles; these pieces are very good choices. As to income measurement, an empirical paper on current cost accounting has been selected for reprinting in the monograph. Overall, these six papers are fine selections that amply demonstrate the essential character of accounting research generated during the 1980s. The survey articles, in particular, will prove helpful to a reader who wishes to quickly capture the essence of the literature in a specific topical research area.

The heart of this monograph is the superb introductory commentary by Mattessich. This material, running for 39 pages of text, concisely develops the five themes given above (as well as a number of sub-themes and related areas) in a way that integrates the significant accounting events and research directions of the 1980s. The commentary is quite comprehensive. It easily compensates for the limited number of reprinted papers that are included in the monograph. Of enormous benefit to the owner/user of this reference work is the bibliographic appendix to the commentary. It is composed of more than 500 reference citations to the supporting accounting literature of the 1980s. Additional assistance is provided by an index of names that encompasses the whole volume (i.e., both the commentary and the six reprints).

Accounting research experienced a near-explosive growth during the 1980s. There was an unprecedented expansion in the volume and a significant escalation in the sophistication level of research outputs. As did its predecessor volume, this monograph neatly captures the essential features of the research landscape. While it is a convenience to have the reprinted articles in the volume, the great value of the monograph lies in the initial commentary. For that portion alone this book is to be highly recommended. Notwithstanding the strong opinions expressed by Mattessich—with which he readily admits many will disagree—regarding the trends in accounting research and the potential for a "crisis" in this arena of endeavor, his commentary stands as an important contribution to the literature. It is both well thought through and deftly written.

Most academic accountants will want to have this volume as part of their reference collection. The monograph can easily be used for graduate-level seminar discussions of contemporary accounting theory and its development. With the wealth of bibliographic reference citations provided, the book also will prove valuable to academic researchers and current doctoral students.

A. J. STAGLIANO
Professor of Accounting
Saint Joseph's University

J. B. RYAN, B. H. ANDREW, M. J. GAFFIKIN, and T. HEAZLEWOOD, *Australian Company Financial Reporting: 1990* (Caulfield, Victoria, Australia: Australian Accounting Research Foundation, 1991, pp. xx, 310, A$40.00, paper).

The book is an Australian counterpart of the AICPA publication in the United States entitled *Accounting Trends & Techniques*, except that publication is irregular instead of annual. The study reviewed herein is the third in a series published by the Australian Accounting Research Foundation. The first study in the series was published in 1975 and surveyed the 1975 financial statements of 250 companies. The second study was published in 1980 and surveyed three years to June 30, 1979. The study under review surveyed the financial statements of the top 150 listed holding companies selected on the basis of market capitalization; it covers the four years ending June 30, 1990.

The main objective of the study is to analyze the financial reporting practices used by the 150 companies whose reports were surveyed, and to publish the results. The authors express the hope that the publication will be of value to the accountancy profession, researchers and students, and the business community generally because of the disclosing of trends and new developments in financial reporting. A point of interest for American readers is that in a book dealing entirely with accounting practice, the 26 contributing authors were all academics.

The organization of the book implies an additional objective of investigating compliance with Australian Accounting Standards. Of the 310 pages in the book, 220 are organized around individual accounting standards issued by the Australian Standards Review Board. Also note the following quotes from a one-page chapter entitled "Highlights": "The highlight of the past decade, and one reflected in the financial statements of the past four years, is the legal status now accorded 'approved accounting standards'" (p. 23) and later in the same paragraph, the author states, "Whereas previously it was not unusual for companies supported by their auditors to depart from the professional standards, that appears to be the case much less with the legally approved standards" (p. 23). The organizational scheme worked reasonably well in this publication; however, it will become unwieldy if accounting standards multiply in Australia the way they have in the United States.

The book is divided into three parts. Part I is 25 pages long and contains five short chapters containing introductory material and general information. As noted above, Part II is 220 pages long and is organized around individual accounting standards issued by the Australian Standards Review Board. Part III is 63 pages long and includes areas of practice either unrelated to sources of authority or covered by:

- professional standards issued by the Accounting Standards Board, not the Accounting Standards Review Board,
- rules of law in The Companies Code, or
- exposure drafts.

Part III also includes an analysis of audit reports.

I believe the book will be well received by its primary audience, but the addition of two features would improve the book. The book does not contain an index, and a work of this type should have one. A brief presentation that describes the evolution of the standard setting process in Australia and explains the relationship among existing sources of authority would help the Australian novice and other readers who are apt to be unfamiliar with these matters. The latter is especially important in view of the organizational scheme used in the book.

BERNARD A. CODA
Professor of Accounting
University of North Texas

FREDERIC M. STINER, JR., M. SUSAN STINER, and ICHIRO SHIINA, *The Accounting Profession in America* (Chiba, Japan: Chuo Gakuin University, 1991, pp. 199, ¥1,300, paper).

This book, written in Japanese, came into existence from the authors' joint research at the University of Delaware, where Ichiro Shiina stayed from February 1988 through September 1989. The objectives of the book, as stated by Shiina, are to analyze the current state of the American accounting profession, with considerable attention to its historical background and the overall American educational philosophy, to judge the current state of the Japanese accounting profession, and to discuss the development of the Japanese accounting profession in the 21st century, based upon a comparative study of the American and Japanese accounting professions (p. 9).

The book has six chapters. The first chapter deals with American accounting education. The authors examine the accounting curriculum at American universities and compare it with the accounting curriculum at Japanese universities. The second chapter provides an overview of professional associations of accountants in America and summarizes career paths for American accounting graduates. Chapter 3 focuses on the educational paths taken by those who advise on tax matters. Chapter 4 describes the American educational philosophy which influences American accounting educational principles and teaching styles. In chapter 5, a comparison of American and Japanese university accounting education is undertaken. Chapter 6, labeled "Accounting Education in Japan," is written in English. This chapter, based upon a paper presented at the annual meeting of the American Accounting Association held in Hawaii in August 1988, is intended for American readers, who are not familiar with the Japanese educational system.

Through a comparison of American and Japanese accounting education, the authors conclude that accounting education is not as effective in Japan as it is in the United States. The authors believe that the quality of the faculty is not as high in Japan as in America, where the faculty is exposed to keener competition. There is also a great difference between American and Japanese teaching styles, although Japanese accounting curricula are apparently similar to those in America. In American universities, "classes are usually discussions between students and professors about problems; they are not usually formal lectures" (p. 3). In Japanese universities, in contrast, "the professor will lecture 90 minutes, with no interruption for questions" (p. 177). "In a Confucian culture, the students will respectfully adopt the teacher's values" (p. 179). Further, Japanese students, once admitted to universities, "are under no pressure to excel" (p. 191); Japanese employers do not want "super students," but harmonious students. Finally, the authors also point out that there is less accounting education research in Japan than in America.

Although the authors present many statistics concerning the educational system of accounting in Japan, their judgment about the effectiveness of Japanese accounting education is mainly based upon Shiina's personal experience. If supported by scientific research, the judgment would be more convincing. The book achieved only part of its stated objectives. Because it placed so much emphasis upon accounting education, it is not a comprehensive comparative study of the American and Japanese accounting professions.

In sum, this book is useful for Japanese readers, particularly to Japanese university professors who want to know how accounting is taught in America. Chapter 6 should be interesting for non-Japanese readers; it provides a good introduction and background for those who are curious about accounting education in Japanese universities.

HIROSHI OBATA
Associate Professor of Accounting
Hitotsubashi University
(Tokyo, Japan)

PETER B. B. TURNEY, *Common Cents: The ABC Performance Breakthrough* (Hillsboro, OR: Cost Technology, 1991, pp. ix, 322, $19.95, paper).

Activity-based costing (ABC) has become one of the most frequently discussed topics in the management accounting literature. The author of this book suggests that ABC represents a major performance breakthrough for the nineties by providing the information and tools needed to improve a firm's business performance.

The book is divided into seven parts and 15 chapters. Each part begins with a summary introduction to the chapters included. Key terms are defined at the end of each chapter. The introductions are useful in that they focus on major points in the chapters. Key terms are repeated at the end of each chapter whenever relevant to an understanding of chapter material.

The first two parts of the book provide a background on problems created by conventional costing systems, along with an introduction to ABC. The author, like some others writing on the subject, places a lot of emphasis on the differences between volume driven and activity-based drivers in an attempt to emphasize the value of ABC. This is somewhat disappointing since various companies have already taken steps to minimize the impact of volume-driven differences.

In chapter 3, the author tends to oversell the merits of ABC somewhat by suggesting that "ABC is a methodology for providing information to help companies improve" (p. 47). This is followed by Figure 3-1, "Rocks and Sharks," suggesting that ABC uncovers problems with poor quality, poor design, and neglected markets. I doubt that ABC provides this capability. Besides, a similar example has been used to suggest advantages of JIT. Although the author makes frequent use of case situations and figures, they often are too general to be of substantial use in understanding the concepts or techniques presented.

The material in parts four and five is very interesting and informative. I enjoyed the author's explanation of two-dimensional ABC. Even so, he appears, once more, to have missed an opportunity to make it easy for the reader to make optimal use of his many examples and figures. Had the author chosen to build on a single case example to provide consistency in his various figures, the material would have been much more informative. Consequently, the reader may not fully grasp the implications of the two-dimensional model. Terminology, by the end of chapter 5, becomes somewhat troubling, especially with respect to the various drivers discussed. The case study at the end of chapter 6 was a good way to summarize material at that point.

Although I think the author was somewhat over zealous in his discussion of activity-based improvement and management, the material was well organized and again informative. I am sure that many would disagree with the author's contention that the tools cited represented activity-based management (ABM) techniques. Although the tools mentioned are helpful to companies as they strive to achieve world-class status, I believe most were developed outside the scope of ABC.

Despite my criticisms, I think the book provides the reader with an excellent explanation of how ABC can help to overcome the significant limitations of conventional cost accounting systems. In addition, it moves well beyond earlier discussions on development of more accurate product costs and makes an effort to provide input on significant management issues. In conclusion, I think the book provides worthwhile reading for anyone contemplating the development of an ABC system.

LARRY N. KILLOUGH
Professor of Accounting
Virginia Polytechnic Institute and State University

THOMAS L. WEST and JEFFREY D. JONES, Editors, *Handbook of Business Valuation* (New York: John Wiley & Sons, Inc., 1992, pp. xxvi, 438, $75.00).

This handbook uniquely augments the existing business valuation literature. The editors have tapped a broad spectrum of appraisers, business brokers, and financial consultants who use their considerable expertise and experience to demystify valuation.

The forty articles that comprise the book, each authored by a separate contributor, are organized into four sections. The first section discusses the purpose and use of business appraisals from varying perspectives, utilizing viewpoints of the appraiser, buyer, seller, lender, and other industry professionals. The section closes with a useful article detailing sources of industry and company data and ways to employ industry information to determine value.

The second section, rather ambitiously, describes the primary methods of business valuation, including the asset-based, market, and income approaches. Additionally, an entire article is devoted to the ubiquitous "rule of thumb method," describing guidelines of valuation for more than 100 small to mid-sized businesses.

The third section has perhaps the most appeal to the general reading audience. A host of articles, incorporating informative industry publications and statistics, illustrate the application of valuation techniques within diverse service, retail, and manufacturing businesses. The book concludes with several topical issues, including information on employee stock option plans, a selection of relevant court cases, and the use, and abuse, of expert opinions.

The organization of the handbook is such that a topic of interest is easily referenced. Each article is short and focused, so a reader can start, and end, their search for information at any point. To capitalize on this feature, an appendix, summarizing the wealth of information found throughout this book, would have been beneficial. For example, Chapter 6 refers, briefly, to federal and state (Maine) lending sources and Chapter 14 describes sources of data for publicly traded companies. Even though the text is indexed, this information is difficult to find if scanning articles at random.

The writing is easy to read and instructive; however, the quality of the articles varies as might be expected with 40 different contributors. Some articles are excellent and quite thorough; others provide the briefest overview and presume prior knowledge of terminology and abbreviations. Readers should be cautioned that, at most, what they will glean from this book as a whole is enough familiarity to understand and assess the valuation process but not enough depth to actually undertake a valuation and pricing decision.

This is a significant caveat because the "rules of thumb" found in Chapter 12, the earnings multipliers given in Chapter 16, the risk premiums in Chapter 18 and other useful guidelines sprinkled liberally throughout applications may entice a reader into performing their own appraisal and sale, despite some authors' admonitions otherwise. Business valuation and related fields of income tax, corporate law, and securities regulation are sophisticated and dynamic disciplines. "Rules of thumb" can become quickly outdated and influenced in our turbulent environment and should not be recklessly applied. As a case in point, the "rules of thumb" presented are based on 1990 and earlier data. The last two years alone have seen unprecedented changes in our economy and the way we do, and undo, business. This will be exacerbated as cost pressures and unemployment mount and interest and inflation rates continue their downward trend.

Overall, this book is a useful collection of information and perspectives on business valuation that should have wide appeal to anyone with an interest in valuation. Its contents will not provide an unsophisticated reader with the definitive valuation of a business; however, it will serve as a helpful precursor for those intending to buy or sell a business.

BARBARA TRENHOLM
Assistant Professor of Accounting
University of New Brunswick

KAZUO YAMAGUCHI, *Event History Analysis* (Newbury Park, CA; Sage Publications, 1991, pp. ix, 182, $13.95).

Event history analysis is a research method used to investigate the causes leading to the incidence of an event. Though widely used in the social sciences, event history analysis has been used sparingly in accounting research. This book, which is part of Sage Publications' Applied Social Research Methods Series, is a practical guide for those interested in using event history analysis.

The risk period for an event is that period of time when an event can occur. For example, the risk period for divorce begins when an individual gets married. Thus, event history analysis is the study of the rate at which events take place (also called the hazard rate) during the risk period or the duration of nonoccurrence of an event during the risk period. These analyses are carried out using parametric methods in which the effects of explanatory variables, or covariates, on hazard rates or duration are determined.

The book includes seven chapters. The first introduces the concepts and terminology of event history analysis. The next five chapters describe various models commonly used as part of event history analysis. These models are the discrete-time logit model, the log-rate model of continuous-time piecewise constant rates, the continuous-time proportional hazard model, the nonproportional model, and the stratified model. The last chapter contains guidelines for using event history analysis in one's own research.

The book's strength is that it is well-written and easy to understand. Even those with limited statistical backgrounds can follow the discussion and the systematic progression from the simpler to more complex models (although the author provides ample references for those wanting a more rigorous discussion). Each of the five chapters devoted to specific models includes an applied example. These applications are in essence mini-studies with instructional narrative included. For example, the author discusses how the input data should be arranged, how the model is specified using common statistical packages such as SAS or SPSS, and how to interpret the parameter estimates.

Upon finishing the book, I found myself wondering about specific accounting questions that might be addressed using event history analysis. There are many, and in fact, most issues can be recast in an events framework. Examples of researchable events include a firm getting a qualified audit opinion, a firm taking large write-offs (i.e., a "big bath"), a firm deciding to use a particular tax treatment, and an auditor being promoted or changing jobs. Though these topics have been researched before, event history analysis can provide new insights because it forces the researcher to look at issues in a different light. For example, to use event history analysis, the researcher must consider when the risk period begins, whether the event is a one-transition or two-way transition (i.e., repeatable event), whether the covariates are time-dependent, whether the duration of nonoccurrence affects the dependent process, and so on.

In sum, I recommend this book to anyone wanting to use event history analysis whether to apply to new research questions or to provide a fresh look at old questions.

STEVEN F. CAHAN
Assistant Professor of Accounting
University of Wyoming

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The deadline for information to be included in the "Placement Information" section is two months prior to the date of publication. The Review is published on the first day of January, April, July, and October. Placement advertising and replies should be sent to the American Accounting Association, 5717 Bessie Drive, Sarasota, FL 34233. ATTENTION: ADVERTISING DEPT. All replies to box numbers should be on separate sheets to facilitate forwarding. There is no charge for this service to AAA members and associate members seeking employment. Others will be charged a fee of $150 per insertion. ADS SHOULD NOT EXCEED 150 WORDS.

#401 FREEMAN SCHOOL OF BUSINESS-TULANE UNIVERSITY invites applicants in accounting for the position of visiting or tenure-track Assistant Professor. Candidates must hold an earned doctorate or expect completion by August 1993. Salary and teaching loads are competitive. Candidates must have a strong research agenda. Quality teaching is expected. Located on the Uptown Campus of suburban New Orleans, Tulane has 40 tenure/track-faculty members and 700 students in BSM, MBA, and Ph.D. programs. Tulane is an Affirmative Action, Equal Opportunity Employer. Send vita and references to: David Harvey, Accounting Search Committee, Freeman School of Business, Tulane University, New Orleans, LA 70118.

#402 LEHIGH UNIVERSITY invites applications for a tenure-track position beginning Fall 1993. Although preference will be given to applicants at the assistant professor level, candidates who show evidence of excellence in teaching and substantial research productivity will also be considered for the associate rank. Candidates must have a Ph.D., DBA, or be near completion. The applicant should have a primary interest in **financial accounting** and/or **information systems**. The Department seeks a balance between teaching performance and research productivity. Our undergraduate programs are fully accredited, including Type A accounting accreditation, as is our college MBA program. Please submit applications before November 13, 1992. Contact: Kenneth P. Sinclair, Chair, Department of Accounting, Lehigh University, Rauch Business Center #37, Bethlehem, PA 18015. Lehigh is an Equal Employment Opportunity/Affirmative Action Employer.

#403 APPLICATIONS FOR POSITIONS IN ACCOUNTING, at all professorial ranks, are invited from qualified persons. A Ph.D. is required. Demonstrated ability or potential for effective teaching and quality research are important considerations. The University of Pennsylvania is an Equal Opportunity/Affirmative Action Employer. Interested persons should send their resumé including educational background, professional experience, publications, personal data, and, if applicable, a dissertation proposal and abstract to: Professor Robert E. Verrecchia, Accounting Department, University of Pennsylvania, Suite 2400, Steinberg Hall-Dietrich Hall, Philadelphia, PA 19104.

#404 GEORGETOWN UNIVERSITY, WASHINGTON, D.C. The School of Business Administration invites applications for a tenure-track faculty position in Financial/Managerial Accounting starting Fall 1993. Candidates should have established records of excellence in teaching and research. We seek a dynamic scholar to accommodate the needs of our growing AACSB-accredited programs. Georgetown is committed to a collegial environment in which salaries, teaching loads, fringe-benefits and research support are excellent. Applications should be received not later than December 31, 1992 and should include vita, research proposals and/or samples of research and teaching record, and names, phone numbers, and addresses of references. Georgetown University is an Equal Opportunity Employer and especially welcomes applications from ethnic minorities and women. Inquiries and applications should be sent to Ms. Virginia Flavin, Director of Faculty Services, School of Business Administration, Georgetown University Washington, DC 20057.

#405 UNIVERSITY OF SOUTHERN CALIFORNIA, School of Accounting is seeking candidates for faculty positions leading to tenure. Faculty positions above the assistant rank are also possible for individuals with strong teaching publication record. Candidates for assistant professor should have a doctorate in hand or be near completion of the dissertation, strong teaching ability and interest in research. The University of Southern California is an Equal Opportunity, Affirmative Action Employer. Applications are encouraged from women and minority persons. Please contact Michael Diamond, Dean, School of Accounting, University of Southern California, Los Angeles, California 90089-1421.

#406 RUTGERS UNIVERSITY'S SCHOOL OF BUSINESS-CAMDEN invites applications for Associate/Full Professor level tenure-track position in financial, managerial or tax accounting. Salary commensurate with qualifications and experience. Ph.D. in Accounting is required. In addition, candidates must have an excellent record of publications in scholarly journals, effective teaching and active professional service. Rutgers University-Camden is located across the Delaware River from Philadelphia and only 50 miles from Atlantic City and the Jersey Shore. Send resumé to Dr. Izzet Kenis, School of Business, Rutgers University, Camden, NJ 08102. Rutgers University is an Affirmative Action/Equal Opportunity Employer.

#407 THE UNIVERSITY OF MANITOBA is seeking applicants for tenure-track positions in accounting for July 1993. Rank and salary open, based on qualifications and experience. A visiting appointment is also possible. Ph.D. or DBA, completed or near completion, is required. Duties include research teaching at the undergraduate and graduate levels. Salary is competitive and will depend on qualifications, experience and research record. Winnipeg, a multicultural city of 600,000 offers the best of an urban environment in the heart of Canada's vacation land. The University of Manitoba encourages applications from qualified women and men, including members of visible minorities, aboriginal people and persons with disabilities. The University provides a smoke free work environment safe for specially designated areas. Priority consideration will be given to Canadian citizens and permanent residents. Applications should be sent to: Dr. Lawrence I. Gould, Head, Department of Accounting and Finance, University of Manitoba, Winnipeg, Manitoba R3T 2N2.

#408 THE JOHN M. OLIN SCHOOL OF BUSINESS is seeking faculty in accounting. The qualifictions include a demonstrated interest in and capacity to do research publishable in leading accounting journals, and a high level of teaching competence in graduate and undergraduate classes. Candidates should hold a doctorate degree or be near completion of the degree. Salary and faculty support are highly competitive. The School has excellent physical, computing and library facilities. Applicants should send curriculum vita and a copy of the dissertation proposal (or the completed dissertation), and other evidence of research activities, to: Vice Dean Lyn D. Pankoff, John M. Olin School of Business, Washington University, Campus Box 1133, One Brookings Drive, St. Louis, MO 63130-4899. Applications should be received by January, 1993. Washington University is an Equal Opportunity/Affirmative Action Employer. We especially welcome applications from women and minorities.

#409 YORK UNIVERSITY, TORONTO is seeking tenure-stream faculty in accounting for July 1, 1993. The primary area of need is financial accounting, but applications will also be accepted in managerial accounting auditing, and taxation (Canadian). International accounting is a desireable ancillary area. Both effective teaching and quality publications will be expected. Willingness to teach with cases is essential. Candidates must possess a doctorate or be close to completion. Assistant professor rank is preferred, but senior appointments will also be considered; rank is dependent upon qualifications. Salary and benefits are competitive. Positions are subject to budgetary approval. York University is implementing a policy of employment equity, including affirmative action for women faculty. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Please send curriculum vitae to: Professor T.H. Beechy, Associate Dean, Academic Faculty of Administrative Studies, York University, North York, Ontario, Canada M3J 1P3.

#410 EMORY BUSINESS SCHOOL seeks applications for a faculty position in accounting. Rank is open. Qualified applicants will possess a doctoral degree (or be close to completion) and evidence a strong commitment to both teaching and research. Applicants with financial accounting research interests and/or ability to teach auditing are encouraged to apply. Salaries and research support are competitive. Applicants with financial accounting research interests and/or ability to teach auditing are encouraged to apply. Salaries and research support are competitive. Applicants should send a vita to: Professor Gregory Waymire, Accounting Area Coordinator, Emory Business School, 1602 Mizell Drive, Atlanta, GA, 30322. Emory University is an Equal Opportunity, Affirmative Action Employer. Applications from qualified minority and female candidates are strongly encouraged.

#411 VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY invites applications and nominations for the William S. Gay, L. Mahlon Harrell Professorships in Accounting and the Arthur Andersen Professorship in Information for Management. Applicants/nominees should have a demonstrated record of excellence in research and teaching. The appointments will be at the senior level with compensation and research supplements provided by the professorships. Applications will be accepted until December 1, 1992 or until the positions are filled. Applications and nominations should be sent to: Wayne E. Leininger, Department of Accounting, 3007 Pamplin Hall, Virginia Tech, Blacksburg, VA 24061-0101. Virginia Tech is an Equal Opportunity Affirmative Action Employer and encourages applications from people of color and women.

#412 VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY invites applications for tenure-track positions at the rank of assistant professor beginning August 16, 1993. Applicant's primary research and teaching (undergraduate and graduate) interests should be in financial accounting or taxation. Qualifications: Doctoral requirements completed and applicants should present demonstrable prospects for conducting scholarly research and excellence in teaching. Applications will be accepted until December 1, 1992 or until the positions are filled and should be sent to: Wayne E. Leininger, Department of Accounting, 3007 Pamplin Hall, Virginia Tech, Blacksburg, VA 24061-0101. Virginia Tech is an Equal Opportunity Affirmative Action Employer and encourages applications from people of color and women.

#413 NORTHERN ILLINOIS UNIVERSITY anticipates tenure-track openings for accounting faculty starting August, 1993. All ranks and fields will be considered and candidates must be qualified to teach at the undergraduate and graduate levels preferably in financial accounting, auditing, or taxation. Candidates should have a terminal academic degree or expect to finish their degree within one year. A CPA or other certification is desirable. Northern Illinois University emphasizes teaching, research and professional activities. We are particularly interested in faculty who want to combine their research and teaching with a close working relationship with practicing professionals. Interested applicants should send their resumé to: John H. Smith, Chair, Department of Accountancy, Northern Illinois University, DeKalb, IL 60115. Applications will be accepted until the position is filled. Northern Illinois University is an Equal Opportunity, Affirmative Action Employer.

#414 ROCHESTER INSTITUTE OF TECHNOLOGY invites applications for a Managerial/Cost Accounting specialist with specific interests in manufacturing, technology accounting, and total quality management. This is a tenure-track position, available Fall 1993, and rank can range from assistant to full professor based on qualifications. A terminal degree in accounting is required and professional certification is desireable. The ideal candidate would be an experienced and innovative teacher with a creditable and continuing research record. Ability to contribute to the college's commitment to cultural diversity is preferred. The College of Business is accredited and salaries are competitive for AACSB-accredited, private universities. The Rochester area has a strong high technology industrial base that should provide the right candidate with research opportunities. Send applications to: Dr. Francis Kearns, College of Business, Rochester Institute of Technology, Rochester, New York 14623-0887, Equal Opportunity/Affirmative Action Employer.

#415 IOWA STATE UNIVERSITY is seeking applications for two tenure-track positions in accounting for August 1993. All specializations considered, with particular interest in auditing and managerial accounting. Rank and salary open, based on qualifications and experience. Ph.D. or DBA, completed or near completion is required. CPA preferred. The College of Business at Iowa State University is AACSB accredited at both the graduate and undergraduate levels. Application deadline: December 1, 1992 or until filled. Send letter of application and vita to: Dr. Labh S. Hira, Chair, Department of Accounting, 300 Carver Hall, College of Business, Iowa State University, Ames, IA 50011-2063. An Affirmative Action Equal Opportunity Employer.

#416 INDIANA UNIVERSITY KOKOMO invites applications for accounting faculty with emphasis in financial accounting an auditing areas. Ph.D./DBA in accounting required, ABD's must complete degree by appointment date of August, 1993. Certifiction (CPA, CMA) and active professional involvement preferred. Scholarly research and effective teaching required. IUK has an established Business undergraduate and a new MBA program. IUK is one of eight Indiana University campuses and serves north central Indiana. Kokomo (population 50,000) is home to GM Delco Electronics (10,500 employees), its Technical and Engineering Center, and a major Chrysler transmission plant (3,500 employees). Accessible to major metropolitan areas, Kokomo is 50 miles to downtown Indianapolis, 130 to Chicago, 165 miles both to Louisville and Cincinnati. Applications from minorities and women are especially encouraged. Contact: Dr. Thomas J. Von der Embse, Dean, Business and Economics, Indiana University Kokomo, 2300 South Washington Street, Kokomo, IN 46904-9003, (317-455-9446).

#417 ASSISTANT/ASSOCIATE PROFESSOR - at the assistant level, the candidate must have a doctorate in accounting or completion of requirements by employment date. Experience in teaching and research is preferred. At the associate professor level, the candidate must have a strong track record in teaching, research, and publication in research journals. Will consider only persons with a *primary* interest in teaching and research in financial accounting with a *secondary* interest in either auditing or managerial accounting. Starting Date: Fall Quarter 1993. Salary: Competitive. To Apply: Send resumé to: Dr. Leonard Eugene Berry, Director, School of Accountancy, Georgia State University, University Plaza, Atlanta, GA 30303. Preference given to applications received before November 1, 1992. An Equal Educational and Employment Opportunity Institution.

#418 VISITING POSITION WANTED: Ph.D. seeks visiting position. Can teach financial, managerial (cost), and accounting information system. Available Fall 1993.

#419 WESTERN NEW ENGLAND COLLEGE, Department of Accounting, has a tenure-track faculty position available beginning fall, 1993. A doctorate in Accounting is required. A strong student orientation and commitment to teaching are required, Although we are primarily a teaching institution, some research is expected for tenure. Salary is competitive. Send letter of application, vita, names of six references with addresses and telephone numbers, and an official transcript of your highest degree work to: Mr. Gregory C. Michael, Director of Personnel Services, Western New England College, 1215 Wilbraham Road, Springfield, MA 01119. *Deadline for applications is December 15, 1992* or until filled. Western New England College is an Equal Opportunity Employer.

#420 THE UNIVERSITY OF TEXAS AT ARLINGTON, Department of Accounting, College of Business Administration is recruiting at the Assistant and Associate Professor levels for one position beginning September 1, 1993 for individuals with an interest in Auditing, Cost, Managerial or Systems. Applicants for the Assistant Professor rank should have the potential for excellence in teaching and research. Candidates at the Associate Professor level should have established records of excellence in teaching and research. Salaries and fringe benefits are excellent. The University of Texas at Arlington is a non-discriminating employer. Women and minorities are strongly encouraged to apply. Send resumé to: Martin Taylor, Chairman; University of Texas at Arlington; Department of Accounting; Box 19468; Arlington, TX 76019-0468.

#421 STONEHILL COLLEGE, NORTH EASTON, MA. The Department of Business Administration has a tenure-track opening for Fall 1993 to teach upper level undergraduate Accounting courses. A doctorate together with professsional certification is required. Rank and salary are open depending on qualifications. Criteria include teaching excellence, business experience, quality of recommendations and scholarly activities. Stonehill is an independent, Catholic undergraduate institution with strong liberal arts orientation. It is located in a suburb of Boston on an attractive 375 acre campus. There are approximately 1900 students of whom 450 are business majors and 125 are business minors. Please send letter of application, resumé and names of at least three references to: William A. Burke, Chairperson, Business Administration Department, Stonehill College, North Easton, MA 02357. Applications will be accepted until the position is filled.

#422 THE UNIVERSITY OF CALIFORNIA AT LOS ANGELES. Applications are invited for positions in accounting at both the junior and senior levels: Applicants must have a Ph.D. degree or be a Ph.D. candidate and exhibit outstanding research capabilities. Resumé should be sent to Professor Kirsten Ely, The John E. Anderson Graduate School of Management, UCLA, Los Angeles, CA 90024-1481. Under federal law, the University of California may employ only individuals who are legally authorized to work in the United States as established by providing documents specified in the Immigration Reform and Control Act of 1986. UCLA is an Affirmative Action, Equal Opportunity Employer.

#423 CLEMSON UNIVERSITY invites applications and nominations for the position of Dean of the College of Commerce and Industry. Candidates should have credentials consistent with a tenured appointment at the rank of Professor as well as (1) commitment to excellence, (2) demonstrated administrative and leadership skills, (3) understanding of higher education and business, (4) strong interpersonal skills, and (5) fund-raising ability. The College consists of three schools: Accountancy; Business; and Textiles, Fiber and Polymer Science. The Master of Accountancy and MBA degrees are offered, as well as MS and Ph.D. degrees in economics, industrial management, and textile chemistry. Active programs exist in professional development, small business, and international exchange. Applicant screening will begin November 15, 1992 and continue until the position is filled. Send applications and nominations to: Holley Ulbrich, Dean Search Committee Chair, College of Commerce and Industry, Clemson University, Clemson, SC 29634-1301. Clemson University is an Equal Opportunity/Affirmative Action Employer.

#424 THE UNIVERSITY OF SOUTH ALABAMA invites applications to fill at least one, and perhaps more, tenure-track positions. Appointments are expected to be at the Assistant Professor level but rank may be open. Although the primary need is in the area of Taxation, other areas, especially Systems and Governmental, may also be open. Applicants should possess a Ph.D. in accounting or be in the final stages of its completion (ABD). The Department of Accounting seeks faculty with a strong commitment to teaching excellence balanced with an active interest in research and publication. The Department offers both masters and undergraduate degrees. The College of Business and Management Studies is fully accredited by the AACSB. Applications will be accepted until December 31, 1992 or until the position is filled. Send letter of application and curriculum vita to: Dr. Gordon S. May, Chair, Department of Accounting, College of Business and Management Studies, University of South Alabama, Mobile, Alabama 36688. The University of South Alabama is an Affirmative Action, Equal Opportunity Employer.

#425 THE UNIVERSITY OF IOWA accounting group invites applications for tenure-track faculty appointments for Assistant and Asssociate positions beginning in the Fall of 1993. The qualifications required include a demonstrated interest in and capacity to do publishable research, and a high level of teaching competence in undergraduate and graduate courses. Candidates are expected to hold a doctorate degree or be near completion of the degree. We offer a competitive compensation package with additional support for both research and teaching activities. Applications should be received by February 1993. Formal application can be accomplished by sending resumé to: Daniel W. Collins, Recruiting Coordinator, Department of Accounting, College of Business Administration, The University of Iowa, Iowa City, Iowa 52242-1323.

#426 IN ANTICIPATION OF A TENURE-TRACK POSITION AVAILABLE FOR THE 1993-94 ACADEMIC YEAR. Rank and salary depend on academic preparation and experience Ph.D. or ABD required for tenure-track appointment. Our program includes a five-year Professional Accountancy Program in addition to baccalaureate curriculum. Send letter of application, vita, three (3) letters of reference and transcripts to: Dr. Charles J. Pineno, Chair, Department of Accountancy, College of Business Administration, Clarion University, Clarion, PA 16214. The screening of applications will begin October 16, 1992. Clarion University is building a diverse academic community and encourages minorities, women, Vietnam era veterans, and persons with disabilities to apply. Affirmative Action/Equal Opportunity Employer.

#427 APPALACHIAN STATE UNIVERSITY'S John A. Walker College of Business is seeking an outstanding person to serve as CHAIRPERSON, Department of Accounting. Qualifications include the doctorate, a demonstrated competency in teaching and research, and the ability to work with the accounting profession. Administrative and leadership ability, public or industrial accounting experience, and certification are preferred. Salary is competitive and commensurate with qualifications. The position is available July 1, 1993. Complete applications must be received by October 23, 1992 and must include letter of application; current resumé; names, addresses, and phone numbers of at least three references; and any additional material which the applicant would like to furnish. Official university transcripts are required prior to appointment. Send applications to: Dr. Randy Edwards, Accounting Chairperson Search Committee, c/o Office of the Dean, John A. Walker College of Business, Appalachian State University, Boone, North Carolina 28608. Appalachian State University is an Equal Opportunity Employer.

#428 POSITION WANTED: Individual seeks faculty position in either a 2-year or 4-year college or university, preferably in the midwest. Four years experience in teaching financial accounting, automated accounting, management, and various office education courses on the 2-year college level. Personal strengths include a commitment to excellent teaching and student advisement. Degrees earned include BSBA, MS, EdS and teacher certification.

#429 THE UNIVERSITY OF ARIZONA'S DEPARTMENT OF ACCOUNTING invites applications for Assistant, Associate, or Full Professors of Accounting. Visiting positions are also available at all ranks. Applicants for Assistant rank should possess a Ph.D. or be nearing completion. Advanced rank applicants must possess an earned doctorate and an established record of recent and continuing research and quality teaching. All tenure-track applicants must be committed to a continuing research program. This announcement will remain open until the positions are filled. Send vita to: Professor Andrew D. Bailey, Jr., Head, Department of Accounting, College of Business, The University of Arizona, Tucson, AZ 85721. The University of Arizona is an Equal Opportunity Educator/Employer, encouraging applications from women and minorities.

#430 NORTHEASTERN UNIVERSITY invites applications for two openings in the accounting group, one tenure-track position and one research chair. Rank is dependent upon qualifications. Most teaching areas can be accommodated, with particular interest in graduate managerial case method teaching. Candidates should hold a doctorate in accounting; demonstrated ability or potential for quality research and effective teaching and service is important. Candidates for a senior position as JOSEPH GOLEMME RESEARCH CHAIR must have a record of continuing published research and the ability to provide leadership in research activities, specifically mentoring of junior faculty. The compensation package and research support are competitive. Northeastern is a private university located in downtown Boston near the Museums, Symphony Hall and Fenway Park. Candidates should send a letter and curriculum vitae to: Shay McKinnon, Group Coordinator; Accounting Group; 404 Hayden Hall; Northeastern University; Boston, MA 02115. Telephone (617) 437-4748. An Equal Opportunity/Affirmative Action Employer.

#431 THE UNIVERSITY OF ALABAMA AT BIRMINGHAM (UAB) invites applications for an anticipated position of Assisstant Professor of Accounting (in the accounting information systems and at least one other area). Applicants should possess a Ph.D. or DBA (ABDs will be considered), as well as the CPA, CMA, or CIA. Contingent on funding, the position (visiting or permanent) will be available for September, 1993. UAB is an Equal Opportunity/Affirmative Action Employer and holds separate AACSB accounting accreditation at the undergraduate and graduate levels. Performance evaluations stress teaching and research equally. Contact Dr. Loudell Robinson, UAB, Department of Accounting, University Station, Birmingham, AL 35294-4460.

#432 ACCOUNTING/INTERDISCIPLINARY STUDIES: Guilford College, Assistant Professor, tenure-track position beginning Fall 1993. Strong commitment to teaching undergraduate at a small liberal arts college; interest in financial accounting and in teaching and participating in the development of interdisciplinary courses. Doctorate and CPA preferred. Guildford is a selective, coeducational Quaker liberal arts college. Guilford College is an Affirmative Action/Equal Opportuity Employer. We actively seek applications from women and minorities. Send state of interest and vita by November 30, 1992 to: Dr. Kathy Adams, Academic Dean, Guilford College, 5800 W. Friendly Avenue, Greensboro, NC 27410.

#433 WAKE FOREST UNIVERSITY, The School of Business and Accountancy, invites applications for the position of Assistant or Associate Professor of Accounting to begin in September, 1993. All applicants should have a doctorate or be ABD with dissertation nearing completion. Candidates in financial accounting are preferred although other qualified candidates may be considered. The School is fully accredited by the AACSB. Wake Forest is an Affirmative Action/Equal Opportunity Employer. Send vita and names of references to: Dale Martin, School of Business and Acountancy, Wake Forest University, Winston-Salem, NC 27109.

#434 SOUTHWEST MISSOURI STATE UNIVERSITY is seeking applicants for the position of Department of Accounting Head. This is a 12-month appointment with a preferred starting date of July 1, 1993. Qualifications include preference for candidates having extensive executive-level accounting leadership experience. Also, CPA or CMA desirable. Credentials must justify tenured appointment. The University enrolls over 20,000 students. The College of Business Administration is the largest of six colleges at the University and consists of 115 faculty serving over 4,000 majors. The Accounting Department is one of six departments in the college and includes 24 faculty members and approximately 1,000 undergraduate majors and 35 Masters of Accountancy students. AACSB accredited at all levels. Screening will begin October 15, 1992. Applicants should forward a vita and three references to: Dr. Douglas Durand, Chair, Accounting Department Head Search Committee, College of Business Administration, Southwest Missouri State University, Springfield, MO 65804-0094. SMSU is an Affirmative Action/Equal Opportunity Employer.

#435 THE UNIVERSITY OF SCRANTON is seeking qualified applicants for tenure-track positions beginning August, 1993. The University is a Jesuit institution with a well-established reputation for quality. It is located in a family-centered, low cost of living community 120 miles from New York City and Philadelphia. Teaching load is nine hours a semester plus research and university service. Salary is highly competitive. Doctorate or ABD in accounting is required. Salary and rank will be commensurate with qualifications and experience. Exceptional candidates will be considered for the Alperin Chair. Please send vita to: Dr. Brian Carpenter, Chairperson, Accounting Department, School of Management, University of Scranton, Scranton, PA 18510-4602. The University of Scranton is an Equal Opportunity Employer; women and minorities are encouraged to apply.

#436 THE WICHITA STATE UNIVERSITY invites applications for a tenure-track position at either the assistant or associate rank beginning August 1993. A teaching/research interest in two of the three following areas is preferred: (1) auditing, (2) taxation, and (3) financial or managerial. Faculty at these ranks are expected to perform quality teaching and service, and interface with the practicing profession. They are also expected to make intellectual contributions which will be shared with their professional and/or academic colleagues. Appointment as assistant professor requires a Ph.D. or DBA degree. (ABDs will also be considered.) Professional certification is desirable. Appointment as associate professor also requires demonstrated excellence in teaching, intellectual contributions, professional interface, and service. To be considered, a vita must be received by January 7, 1993 (or monthly thereafter until the position is filled) by Professor James W. Deskins. Director, School of Accountancy, The Wichita State University, 1845 Fairmount, Wichita, KS 67260-0087. Affirmative Action/Equal Opportunity Employer.

#437 INDIANA UNIVERSITY SOUTHEAST invites applications for two positions as Assistant or Associate Professor in Accounting. Appropriate DBA or Ph.D. required; CPA, CMA, or CIA preferred. ABD considered. Primary teaching responsibility for one position in accounting information systems, for second position in tax. Each position must assume secondary responsibility in one other area (managerial, financial, auditing). Teaching load 9 hours; 2 preparations normal. Balanced teaching and research expectations. IUS, and AACSB accredited campus of Indiana University, is located in the Louisville, KY Metropolitan area. The university offers a small campus atmosphere (5,800 students) with resources of a large university system. The Division of Business offers the BS in Business, and the MBA degree. Applications received before November 15, 1992 will be assured of consideration. Positions will remain open until filled. Send vita to: Professsor Vicki Meredith, Indiana University Southeast, 4201 Grantline Road, Box 92-4, New Albany, IN 47150. IUS is an Affirmative Action/Equal Opportunity Employer.

#438 THE UNIVERSITY OF ILLINOIS AT CHICAGO (UIC) invites applications and nominations for faculty positions at all ranks in Accounting. Candidates, preferably in financial accounting, should possess a strong research record, commitment to teaching excellence and professional service. UIC, one of 70 Research I universities in the U.S., is a cosmopolitan campus with 25,000 students near Chicago's business district. The Department of Accounting has 900 undergraduate majors and 30 MS students. It also serves the 2,000 undergraduates in other disciplines, 550 MBA students, and other graduate students in the College of Business Administration. Communications should be addressed to: Ronald D. Picur, Acting Head, Department of Accounting (M/C) 006), University of Illinois at Chicago, Box 802451, Chicago, IL 60680-2451. The University of Illinois is an Affirmative Action, Equal Opportunity Employer.

#439 INDIANA UNIVERSITY, Department of Accounting, invites applications for tenure-track accounting faculty positions. Qualifications include a doctoral degree and commitment to excellence in research and teaching. Applications should be received by February 15, 1993. Please forward vita, letters of recommendations, research proposal, and evidence of qualifications to: Professor Mikel G. Tiller, Chair, Department of Accounting, School of Business, Indiana University, Bloomington, Indiana, 47405. Indiana University is an Equal Opportunity Employer.

#440 THE UNIVERSITY OF NORTHERN IOWA invites applicants for two tenure-track positions in Accounting, at the Associate or Professor rank beginning Fall 1993. While all areas will be considered, the primary needs are Tax and Managerial. An earned doctorate, a record of scholarship consistent with rank and teaching excellence are expected; professional certification is desirable. The CBA has 68 full-time faculty members, approximately 1,400 undergraduate majors and 150 MBA students. A new $10 million CBA building was occupied in August 1990. Cedar Falls, a pleassant residential community (35,000) and adjacent Waterloo (75,000) form an area with outstanding educational, cultural, medical and recreational options in Northeast Iowa. Applications accepted until positions are filled. Contact Professor Gerald Smith, Head, Department of Accounting, College of Business Administration, University of Northern Iowa, Cedar Falls, IA 50614-0127. (319) 273-2394. UNI is an Equal Opportunity Educator and employer with a comprehensive plan for Affirmative Action.

#441 BOWLING GREEN STATE UNIVERSITY is seeking applications for tenure-track positions (assistant or associate) and temporary instructors in accounting and management information systems starting January 1993 or August 1993. Requirements for the tenure-track positions are a Ph.D. or equivalent (or an advanced-stage ABD at the assistant level) and a commitment to teaching and research. Associate candidates must have a commensurate teaching, research, and service record. Applicants with primary emphasis in accounting systems and auditing are particularly urged to apply. Instructor applicants should hold an appropriate master's degree and preferably have professional certification. The University, a state-supported institution with 16,000 students, is located 25 miles south of Toledo. Applications and inquiries should be directed to: Professor Park E. Leathers, Chair, Department of Accounting and MIS, Bowling Green State University, Bowling Green, Ohio 43403. Bowling Green is an Equal Opportunity/Affirmative Action Employer. Minorities and Females are encouraged to apply.

#442 DUQUESNE UNIVERSITY anticipates two tenure-track positions in accounting (one managerial and one financial) at the Assistant, Associate or Professor level starting Fall 1993. A Ph.D. or DBA is required (ABD considered). Necessary qualifications include commitment to teaching excellence and quality research. Teaching is at the undergraduate and MBA levels with a maxmium of 9 hours per semester. The University's School of Business is accredited by the AACSB. Duquesne is a private Catholic University with an enrollment of 8,000 students. There are approximately 1,000 undergraduate business students and 600 MBAs. Located in Pittsburgh, Duquesne offers all the advantages of a quiet, self-contained campus with all the resources of a major metropolitan center. Salaries are competitive and fringe benefits are excellent. The University is an Equal Opportunity, Affirmative Action Employer. Send vita and references to: Dr. Kenneth L. Paige, Chair, Accounting & Finance, A.J. Palumbo School of Business, Duquesne University, Pittsburgh, PA 15282.

#443 GEORGE WASHINGTON UNIVERSITY, Department of Accountancy invites applications for two tenure-track Assistant Professor positions, one in Auditing and one in Financial Accounting. Candidates are expected to possess a doctoral degree and should be dedicated to teaching excellence and research. Candidates with published research are preferred. The Department of Accountancy is one of nine departments in the School of Business and Public Management and serves undergraduate students in Accountancy, Taxation and related fields. The University is a multicultural institution located in an urban environment. GWU is an Equal Opportunity, Affirmative Action Employer. Please send vita to: Dr. Debra R. Sheldon, Chair, Department of Accountancy, George Washington University, 710 21st Street, NW, Room 209, Washington, DC 20052. Telephone (202) 994-6825. Salary is competitive and the application deadline is November 1, 1992.

#444 GEORGE MASON UNIVERSITY. The Department of Accounting invites applications at all academic ranks for positions beginning September 1993. Ph.D. or DBA (or completion by appointment date) required. Preference for experienced individuals in areas of auditing, managerial, or taxation. Candidates for assistant professor positions should have potential for excellence in teaching and research. Candidates for positions at higher ranks should have an established record of excellence in teaching and research. George Mason University is a state supported institution located in the Washington, D.C. metropolitan area. The School of Business Administration offers AACSB business and accounting accredited undergraduate and graduate degree programs. Applicants should send vita, transcripts references, research propossals and/or samples of research to: Dr. Kenneth Heller, Department Chair, Accounting & Business Legal Studies Department, Robinson B Room 441, George Mason University, Fairfax, VA 22030-4444. George Mason University is an Affirmative Action/Equal Opportunity Employer.

#445 CORNELL UNIVERSITY, S.C. JOHNSON GRADUATE SCHOOL OF MANAGEMENT -Position opening for Assistant, Associate or Full Professor of Accounting. Responsible for teaching basic and advanced courses in accounting at the Master's level; research in area(s) of expertise and interests; supervision of doctoral candidates; and interdisciplinary contribution to the research and teaching of other faculty members. Direct inquiries to: Professor John A. Elliott, S.C. Johnson Graduate School of Management, 521/A Malott Hall, Cornell University, Ithaca, NY 14853. Applicants should have completed a doctorate or be at the dissertation stage of a doctoral program. Applications should include a vita, together with a dissertation proposal or abstract, and copies of research papers. Affirmative Action, Equal Opportunity Employer.

#446 THE UNIVERSITY OF MISSOURI-COLUMBIA SCHOOL OF ACCOUNTANCY is seeking applications for a tenure-track appointment for Fall 1993. Deadline for receipt of applications is February 1, 1993. Candidates will be considered for a position at either the Assistant or Associate Professor level, with emphasis in areas in accounting systems or financial accounting. A Ph.D., DBA, or ABD near completion is required. Faculty members generally teach six hours per semester and are expected to be actively involved in research and professional service. Salary and research support are competitive. The University of Missouri is an Equal Opportunity, Affirmative Action Employer. Applications from minority members and women are encouraged for these positions. Please send vita to: Dr. Raymond C. Dockweiler, Director, School of Accountancy, University of Missouri-Columbia, 312 Middlebush Hall, Columbia, Missouri 65211.

#447 LOUISIANA STATE UNIVERSITY, Department of Accounting invites nominations and applications for the Thomas H. Daigre Chair, available August 1993 pendng final approval. Applications will be accepted until position is filled. The position requires a doctoral degree, an outstanding record of academic research and experience in teaching doctoral seminars and directing dissertations. The recipient will be expected to publish academic research, teach primarily at the doctoral level, direct dissertations and assist untenured faculty in developing a scholarly record. Salary is competitive and commensurate with qualifications and experience. Please send nominations and resumé to: Bart P. Hartman, Accounting Alumni Distinguished Professor and Chair, Faculty Recruiting Committee, Department of Accounting, 3101 CEBA Building, Louisiana State University, Baton Rouge, LA 70803. The University is an Equal Opportunity, Affirmative Action Employer.

#448 THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL. The Kenan-Flagler Business School is seeking to fill one or more positions in accounting. Rank is open but individuals at the senior assistant or higher levels are preferred. Applicants for tenure-track positions must have a Ph.D. in Accounting and outstanding research potential (or demonstrated research productivity for non-entry level position), and a strong commitment to excellence in teaching. A fixed-term appointment (adjunct) may be available for an individual with a Ph.D. in Accounting and an outstanding research or teaching record. The University of North Carolina at Chapel Hill is an Affirmative Action Employer. Minorities and women are encouraged to identify themselves voluntarily. Send a letter of application and curriculum vita to: Howard Rockness, Chair, Accounting Search Committee, CB 3490, Ken-Flagler Business School, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599.

#449 THE UNIVERSITY OF ALABAMA IN HUNTSVILLE invites applications for positions in accounting at the Assistant, Associate, or Full Professor level for Fall 1993. Ph.D. or DBA required. CPA, CMA, or CIA preferred. Professional experience preferred. Excellent teaching, research, and professional service records required for appointment as Associate or Full Professor. Teaching interest is required in at least two of the following areas, depending upon the needs of the department: taxation, auditing, systems, financial, governmental, cost/managerial, with most critical needs in tax, auditing, and systems. Interest in Federal government accounting is desirable. Preference will be given to candidates who apply by November 15, 1992, but the positions will remain open until filled. Applications should be sent to: Dr. Pierre L. Titard, Chairman, Accounting Search Committee, Department of Accounting and Business Legal Studies, The University of Alabama in Huntsville, Huntsville, Alabama 35899. UAH is an Affirmative Action/Equal Employment Opportunity Institution.

#450 THE UNIVERSITY OF SOUTH FLORIDA School of Accountancy invites applications for one tenure-track position at the Associate or experienced Assistant Professor level beginning January or August 1993. Candidates must have a record of excellence in teaching, an ongoing stream of research and publication, and experience as a faculty member in a doctoral program including work on doctoral dissertation committees. Applicants should be capable of assuming a leadership role in the Ph.D. program. Teaching requirements will include a doctoral capital markets seminar and undergraduate and/or graduate courses. The University of South Florida is a comprehensive research, teaching and service university in metropolitan Tampa, the financial and economic hub of Florida's west coast. Please submit applications by November 13, 1992 to: Dr. Karen L. Hooks, School of Accountancy BSN 3403, University of South Florida, Tampa, FL 33620-5500. Position subject to funding. USF is an Equal Opportunity Affirmative Action Employer.

#451 THE ROBERT O. ANDERSON SCHOOL OF MANAGEMENT AT THE UNIVERSITY OF NEW MEXICO is seeking candidates for an assistant/associate professor position in accounting. Applications should possess a doctorate (or be ABD) in accounting or related field and evidence potential for a significant, ongoing program of research, as well as strong teaching credentials at the undergraduate and masters levels. The primary teaching focus will be in the area of taxation; however, strong candidates with diverse teaching interests are encouraged to apply. The closing date for applications is December 31, 1992. Address applications to: Professor Jesse F. Dillard, Area Coordinator, Anderson School of Management, University of New Mexico, Albuquerque, NM 87131. The University of New Mexico is an Equal Opportunity/Affirmative Action Employer and strongly encourages applications from women and minority group members.

#452 UNIVERSITY OF MARYLAND AT COLLEGE PARK invites applications for a faculty position in Accounting at either the Assistant Professor or Associate Professor level, to start in August 1993. The minimum qualification for Assistant Professor is a Ph.D. degree. A candidate for Associate Professor should have a distinguished publication record and a record of quality teaching. Interested candidates should have a distinguished publication record and a record of quality teaching. Interested candidates should send resumé to: Professor James P. Bedingfield, College of Business and Management, University of Maryland at College Park, College Park, MD 20742. For advantageous consideration, applications must be received by January 21, 1993. The University of Maryland is an Equal Opportunity/Affirmative Action Employer. Women and minorities are encouraged to apply.

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1. The application must be complete in all respects; i.e., the required number of forms requested, recommendation letters, and graduate admissions test scores.
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Marie Hamilton, Office Manager
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5717 Bessie Drive
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The program is administered by a committee composed of members of the American Accounting Association.

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The American Accounting Association's Student Fellowship Committee met recently to select the 1992-93 recipients of the American Accounting Association grants. The committee was chaired by Stanley Biggs, University of Connecticut, Constantine Konstans, KPMG Peat Marwick, and Kurt J. Pany, Arizona State University. The Fellowship Committee was authorized to grant $1,000 awards for 1992-93 to outstanding applicants based only upon academic merits. The Committee selections were based upon the applicants' attributes and accomplishments and were made without distinction as to the school at which the applicant would pursue the doctoral studies. The Committee reviewed fifty-two applications and granted ten awards of $1,000 each. The Fellowship Award winners were:

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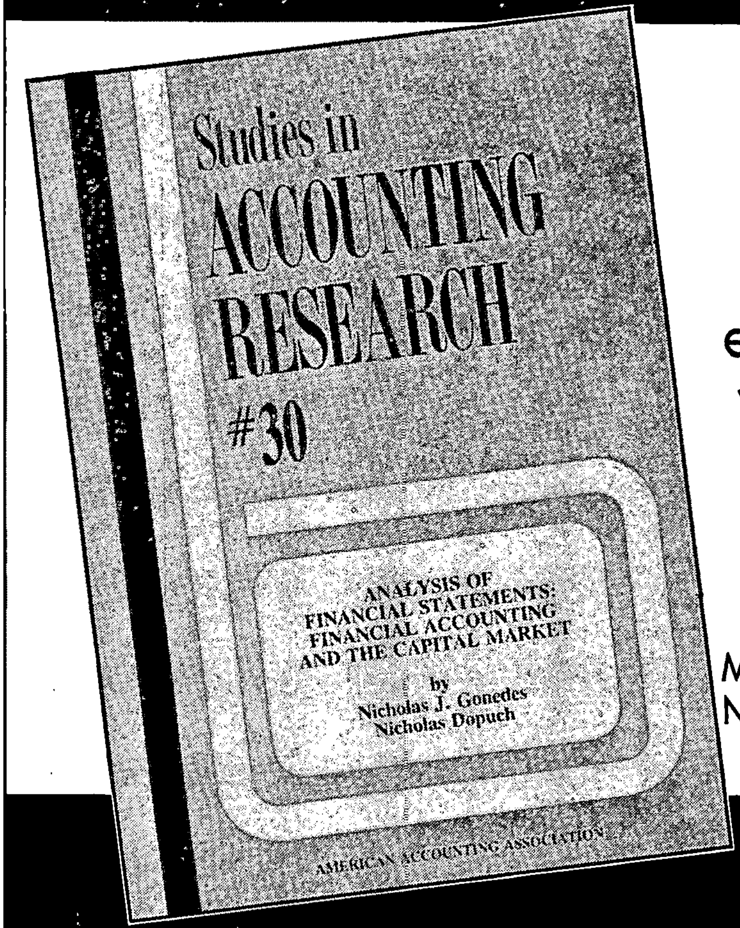

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Proceedings of the Kobe Forum held at the Kobe International Conference Center, Kobe, Japan, in November 1991, organized by the Research Institute for Economics and Business Administration, Kobe University, in cooperation with the Graduate School of Industrial Administration, Carnegie Mellon University

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The Ohio State University
John J. Gerlach Chair in Accounting

The Department of Accounting & Management Information Systems and the College of Business of The Ohio State University are pleased to announce the availability of the John J. Gerlach Chair in Accounting. Nominations and applications will be accepted until November 15, 1992 or the position is filled.

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Qualifications: Doctorate in Accounting or a related field; teaching and research records consistent with College's standards for appointment as a Full Professor.

Salary: Very competitive.

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